Agricultural Engineering Advancements:

A Compendium of NIAE Webinar Series

Volume 1

Editor

Engr. Dr. John Audu

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Produced by

Nigerian Institution of Agricultural Engineers

Editor

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Acknowledgements

As the National Chairman of the Nigerian Institution of Agricultural Engineers (NIAE), it is both an honor and a privilege to extend my heartfelt gratitude to all those who have contributed to the creation of this remarkable book, " Agricultural Engineering Advancements: A Compendium of NIAE Webinar Series." This book represents the culmination of our collective efforts and serves as a testament to our dedication to advancing the field of agricultural engineering and emerging technologies.

I wish to express our deepest appreciation to our members, presenters, and attendees who actively participated in the series of professional development webinars that inspired the content of this book. Your unwavering commitment to knowledge sharing and professional growth has been the driving force behind the success of this endeavor.

I want to extend special thanks to the organizing committee, whose dedication and hard work ensured that each webinar was a resounding success. Your meticulous planning and attention to detail have provided the foundation upon which this book now stands.

Our gratitude also extends to the authors, whose insightful contributions have filled the pages of this compendium. Your expertise and willingness to share your knowledge have made this book a valuable resource for agricultural engineers and technologists alike.

Furthermore, I would like to acknowledge the support of our sponsors and partners, whose generosity made it possible to bring these webinars to our members, and ultimately, to compile this book.

Last but not least, I am deeply thankful to the NIAE executive council, staff, and all those who have dedicated their time and energy to advance the mission of our institution. Your unwavering commitment to promoting excellence in agricultural engineering and technology has been the cornerstone of our success.

In closing, I believe that "Agricultural Engineering Advancements" will stand as a testament to the dedication and collaborative spirit of the NIAE community. As we continue to strive for excellence in the field of agricultural engineering, may this book serve as a source of knowledge, inspiration, and innovation for generations to come.

Sincerely,

Prof. A. F. Alonge. PhD. FNIAE

National Chairman Nigerian Institution of Agricultural Engineers (NIAE)

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INTRODUCTION TO ARTIFICIAL INTELLIGENCE

CIGR_AI_NIGERIA

Webinar Presentation

Adeyemi O. Adegbenjo, PhD

Agricultural and Environmental Engineering Department

July 29, 2021

SPEAKER PROFILE

McGill University trained expert in Bioresource Engineering with specialty in Hyperspectral Imaging and Machine Learning

Former Research Associate at the Biological Imaging Laboratory, School of Engineering, University of Guelph, Canada

2018 McGill University Doctoral Internship Award winner

2018 World Vision Canada Food Security Social Innovation Challenge Award Winner

2021 UDACITY Black in Technology Scholarship Award winner in Programming for Data Science with Python

Adeyemi O. **Adegbenjo**

- BSc., MSc. Agricultural Engineering (OAU)
- PhD Bioresource Engineering (McGill)
- Registered Engineer (COREN)
- Member ASABE, CSBE, NIAE, NSE

OUTLINE

- Background
  - Webinar Approach
  - History of AI
  - Basic definitions
- Machine learning
- Deep learning
- Data
- Modelling platforms
- Evaluation metrics
- Introduction to WEKA
- Conclusion

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APPROACH

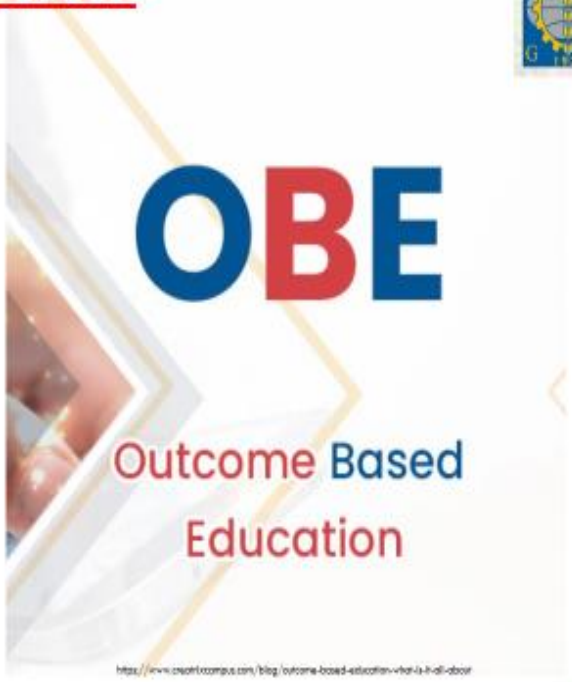
LEARNING

COMPETENCY

LEARNING TEACHING

COMPETENCY

LEARNING



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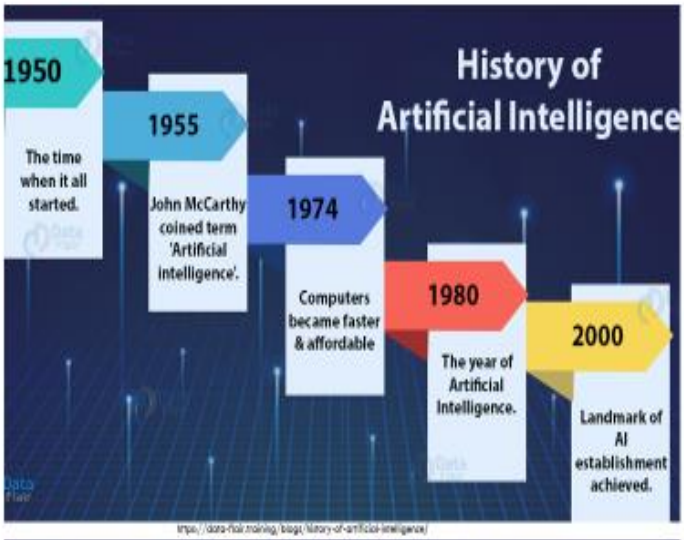


HISTORY

- Alan Turing publication 1950
- John McCarthy 1955
- Dartmouth conference 1956 (John McCarthy and Marvin Minsky
- AI winter 1970-1980
- Rebirth of AI 1990-Now
- AI has become the new electricity of our lifetime- Andrew Ng
- Yoshua Bengio, Geoffrey Hinton and Yann LeCun
  - 2018 ACM A.M. Turing Award

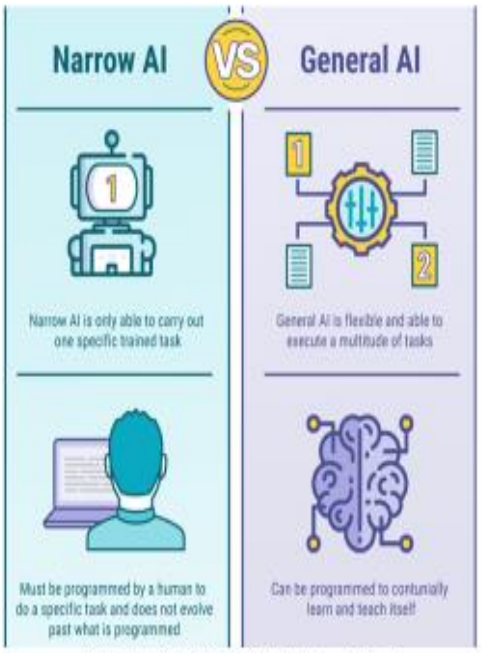
MYTHS

AI and ML Are the Same

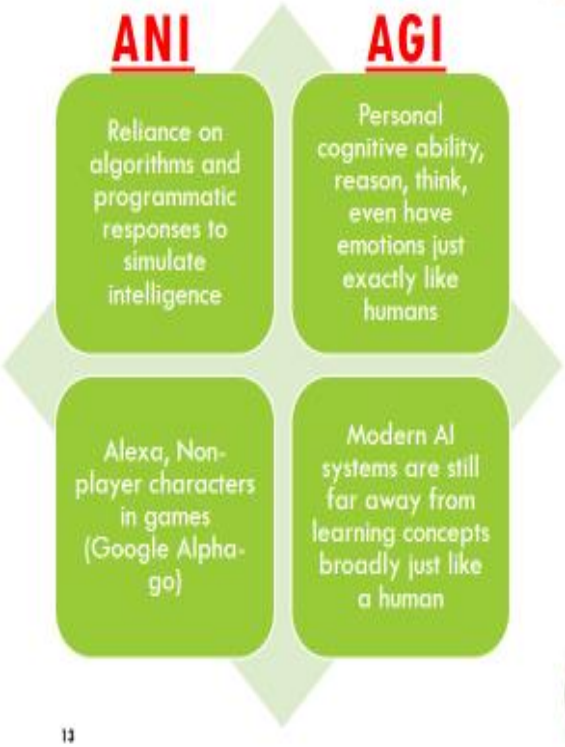
You Need a Ph.D to Understand AI and ML

AI and ML Will Replace Me

BASIC DEFINITIONS



https://smartcompliance.co/blog/artificial-intelligence-improve-compliance



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BEHIND THE BOX?

https://www.istockphoto.com/illustrations/behind-the-scenes

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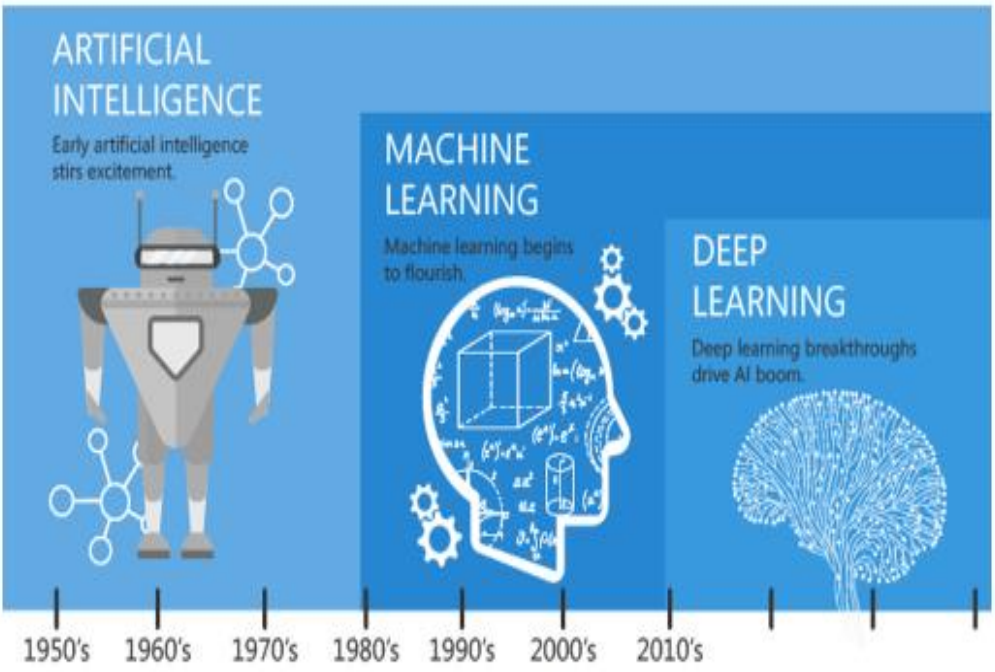
BEHIND AI SYSTEM



https://towardsdatascience.com/artificial-intelligence-vs-machine-learning-vs-deep-learning-2210ba8cc2ac

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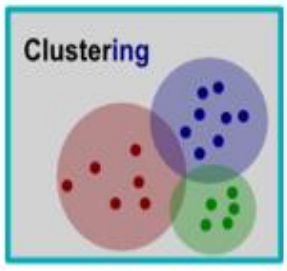
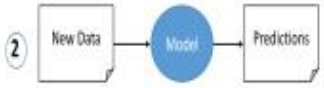
MACHINE LEARNING (ML)



UNLABELED DATA

(UNSUPERVISED LEARNING)



https://www.logianalytics.com/predictive-analytics/what-is-predictive-analytics/

LABELED DATA

(SUPERVISED LEARNING)

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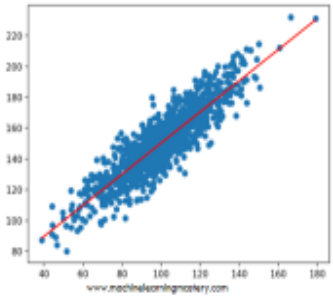
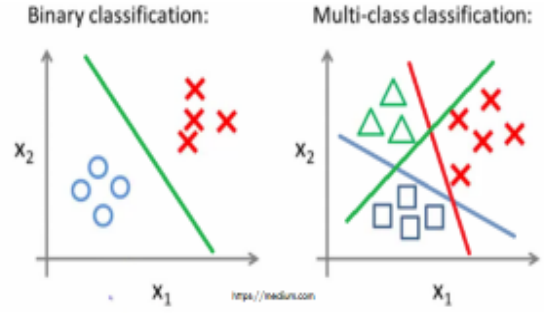
PREDICTIVE ANALYTICS

Regression



- Quantitative models
  - Numeric
  - Continuous



- Qualitative models
  - Categorical

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ML ALGORITHMS

SVM	KNN	Logistic Regression	Ada Boosting
RF	Decision Trees	Bagging	K-means
Linear Regression	LDA	Gradient Boosting	Naïve Bayes

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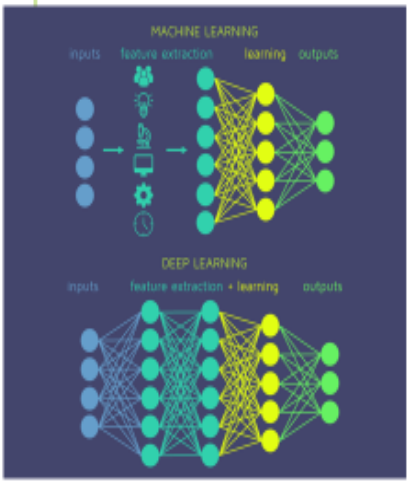
DEEP LEARNING



- ANNs: FFW-RBFNs (classification, regression, time series), FFW-MLPs (machine translation, speech recognition, image recognition)
- CNNs (Image processing and object detection)
- RNNs (Natural Language Processing)
- GANs (Image generation, cartoon characters, etc)
- SOMs (Data visualization and dimension reduction)
- DBNs (Motion capture, image and video recognition)
- RBMs (Dimension reduction, classification, regression)
- Reinforcement learning (Robotics)
- Autoencoders (Image processing, pharmaceutical discovery, popularity prediction

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DATA

https://cbiz.org/articles/2020/03/03/adv-all-knov-accounting-teams-can-leverage-big-data.aspx

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MACHINE LEARNING WORKFLOW

1. Problem identification
2. Data acquisition
3. Data pre-processing
4. Feature extraction
5. Dimension reduction
6. Model building
7. Model validation
8. Model verification
9. **Deployment**

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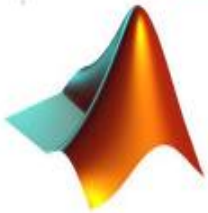
MODELLING PLATFORMS









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EVALUATION METHODS

- **Holdout set**: The available data set *D* is divided into two disjoint subsets,
  - the *training set* D_{train} (for learning a model)
  - the *test set* D_{test} (for testing the model)
- **Important:** training set should not be used in testing and the test set should not be used in learning.
  - Unseen test set provides an unbiased estimate of accuracy.
- The test set is also called the holdout set.
- **This method is mainly used when the data set *D* is large.**

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EVALUATION METHODS (CONT…)

- **n-fold cross-validation**: The available data is partitioned into *n* equal-size disjoint subsets.
- Use each subset as the test set and combine the rest *n*-1 subsets as the training set to learn a classifier.
- The procedure is run *n* times, which give *n* accuracies.
- The final estimated accuracy of learning is the average of the *n* accuracies.
- 10-fold and 5-fold cross-validations are commonly used.

This method is used when the available data is not large.

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EVALUATION METHODS (CONT…)

- **Leave-one-out cross-validation**: This method is used when the data set is very small.
- It is a special case of cross-validation
- Each fold of the cross validation has only a single test example and all the rest of the data is used in training.
- If the original data has *m* examples, this is *m*-fold cross-validation

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EVALUATION METRICS

Regression	Classification
▪ Correlation coefficient (R_c , R_v) ▪ Coefficient of determination (R^2) ▪ Root mean square errors ($RMSE_c$ and $RMSE_v$)	▪ Confusion matrix ▪ ROC and ▪ AUC

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CONFUSION MATRIX

Prediction class

True class		Predicted as Positive	Predicted as Negative
	Actually Positive	True Positives (TP)	False Negatives (FN)
	Actually Negative	False Positives (FP)	True Negatives (TN)

OVA = (TP+TN)/ (TP+FN+FP+TN) * 100 TPR = TP/ (TP+FN) * 100 TNR = TN/(TN+FP) * 100

PPV = P = TP/ (TP+FP) * 100 NPV = TN/ (TN+FN) * 100

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WEKA PLATFORM

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TAKE HOME MESSAGE

- AI with the present digital transformation age present opportunities for Nigeria to be at the forefront of the fourth industrial revolution
- We as Nigerian Engineers, academic and researchers must be at the forefront leading African Professionals in proffering African solutions to African problems
- Our blueprint should involve collaborative efforts of the private, public sectors, and the academia.

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WE ARE ABLE.....

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THANK YOU

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Application of Artificial Intelligence in Agriculture and Food Sector

Applications of Artificial Intelligence (AI) in Agriculture

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Agric & Bio Environ. Eng. Dept
Lagos State Polytechnic, Ikorodu
Lagos, Nigeria

❑ *QUALIFICATIONS*

- *Ph.D. Systems Engineering* **(University of Lagos, Akoka , 2008)**

  "E-Nose Odour Recognition System for Produce Quality Assessment." (Funded by Grant from the University of Lagos Research Council and supported by Cocoa Industries Ltd, Ikeja).Supervised by: Professor V.O.S Olunloyo (UNILAG) and T.A Ibidapo (Leventis Nig Plc)

- ***MSc in Agricultural Engineering*** **(Obafemi Awolowo University, Ile Ife, Osun State 1992)** "Mathematical Modeming of the Force-Deformation Characteristics of Cocoa Pods." Supervised by: Professor M.O Faborode
- *B.Tech Agricultural. Engineering* **(FUT, Akure, 1988)**

❑ Registered Engineer, COREN, MNSE, MNIAE, MNCS

❑ **SKILLS, INTERESTS AND RESEARCH THRUST**

- Process and machine development
- Sensors, instrument control systems for monitoring and process automation and environmental control.
- Data analysis, data mining and modelling , Artificial Neural Networks,
- Automation / Machine Hardware Control Programming - LabView
- Smart crop and animal farms, soilless agriculture

Contents

- Introduction
- Artificial Intelligence, Data and Internet of things
- Some Applications
  - Drones and Remote sensing technology
  - Robotics in Agriculture
  - Automated irrigation
  - Expert systems, knowledge-based agriculture
  - Intelligent systems for animal husbandry
  - AI in food engineering – traceability and distribution chain logistics
  - Machine vision, Automatic navigation and self-driving technology
  - Conclusions

Introduction

The World needs more food, feed, fibre and fuel

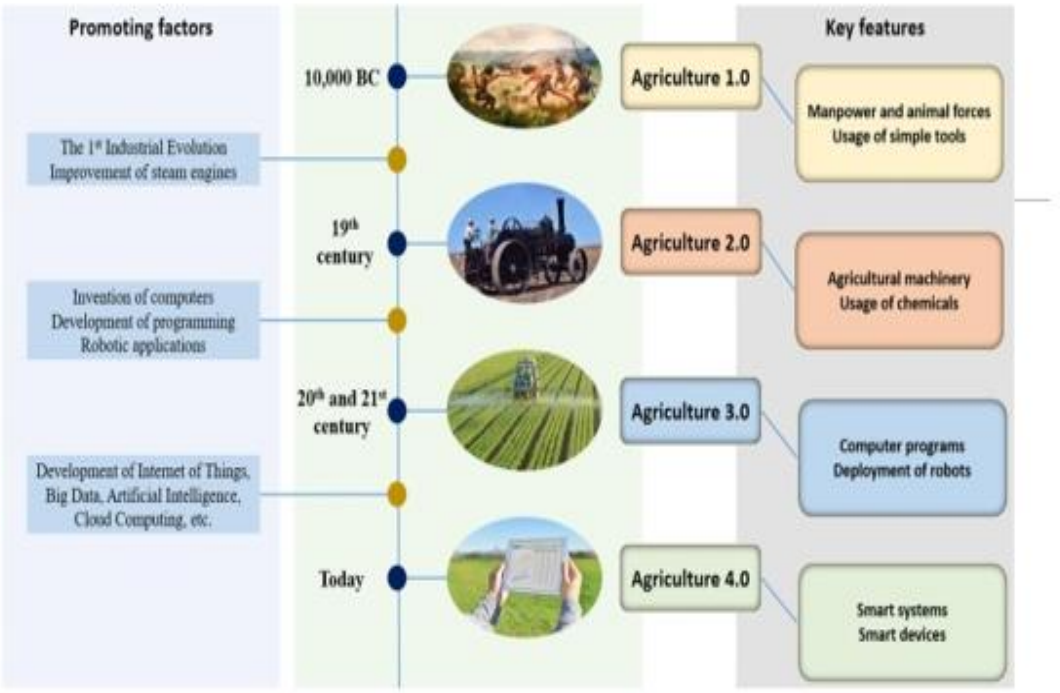
- World population predicted to exceed 9.0 billion people by year 2050 (FAO, 2009).
- Conventional methods of increasing rate of food production : mechanization, improved genetics and increased use of inputs have attached costs - depletion of soils, water scarcity, widespread deforestation and high levels of greenhouse gas emissions (FAO, 2017; NASEM, 2019).
- Revolution needed - innovative and effective solutions , maximising outputs from available resources, insights from multiple disciplines, using them in an integrated way. One promising way is the application of Artificial Intelligence (AI).

Revolutions in Agriculture:

Revolutions in agriculture have gone hand-in-hand with the innovations in the industrial sector .

- Agriculture 1.0 - animal power enhanced agriculture ;
- Agriculture 2.0 – the era of the combustion engine
- Agriculture 3.0 - guidance systems and precision farming, starting when military GPS-signals were made accessible for public use.
- Agriculture 4.0 farm activities are connected to the cloud.
- Agriculture 5.0 includes digitally-integrated enterprise, with production processes using robotics and some forms of artificial intelligence.

Verónica Saiz-Rubio and Francisco Rovira-Más (2020) : *From Smart Farming towards Agriculture 5.0: A Review on Crop Data Management* Agronomy Volume 10 Issue 2 10.3390/agronomy10020207



FAO (2020) : AGRICULTURE 4.0 Agricultural robotics and automated equipment for sustainable crop production

Figure 2. Comparison between a smart farm (Agriculture 4.0) and a small-scale farm (conventional agriculture)

Notes: Robotics refer to systems or machines where increased levels of intelligence are added to the machine for its autonomous work or a new intelligent machine is developed for an existing application. Automated equipment refers to existing systems, where some elements have been automated for transporting or working without human intervention.

FAO (2020) : AGRICULTURE 4.0 Agricultural robotics and automated equipment for sustainable crop production

What is AI ?

The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making and translation between languages.

AI techniques … solve the kinds of problems ***previously reserved*** for humans" - McCarthy in 1956

AI and Agriculture

Artificial Intelligence (AI) has be applied across disciplines, and it has also brought a paradigm shift in how we *see farming* today. AI-powered solutions will not only enable farmers to do more with less, it will also improve quality and quantity ensure faster rate of production.

New opportunities for ***businesses and entrepreneurs who wishes to enable smart farm as a service*** .

Today, AI, Big Data and the Internet of Things (IoT) are the major driving forces behind increased agricultural production at a lower cost. This has left the doors wide open for engineers to come up with smart IoT-based solutions that enhance agricultural productivity in a cost-effective manner

Big Data, AI and IoT

Big data, AI, IoT are different technologies, and each one of them has emerged and evolved in independent ways. But for some years, there are developing interdependence and opening up new possibilities of innovations, enhanced efficiency, and productivity benefits.

BigData and AI are merging into a synergistic relationship, where AI is useless without data, and mastering data is insurmountable without AI.

On the other hand, AI is continuing to play a significant role in the connected ecosystem of devices (IoT) and for allowing machines to perform certain tasks based on data-driven user insights.

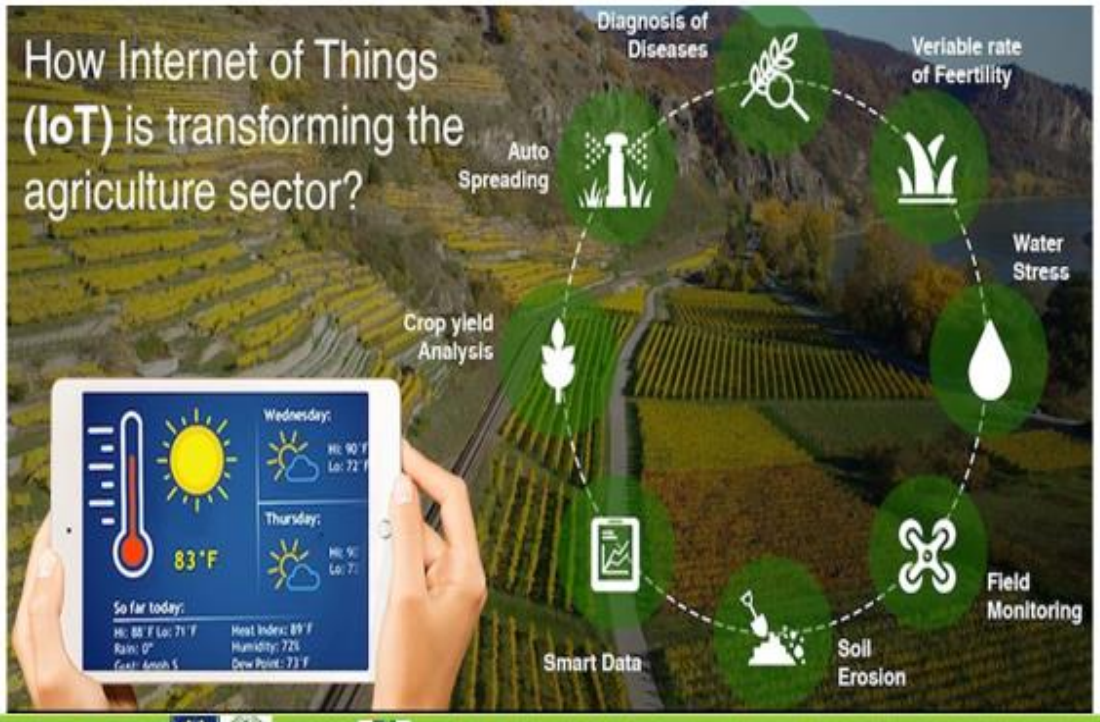
> *Convolution of Big Data, Connectivity and AI responsible for Israel's success in Agriculture today– Netanyahu former Israeli PM*

INTERNET OF THINGS

On farms, **IOT** allows devices across a farm to measure all kinds of data remotely and provide this information to the farmer in real time. **IOT** devices can gather information like soil moisture, chemical application, dam levels and livestock health - as well as monitor fences vehicles and weather.

Huge volumes of data get generated every day on historical weather pattern, soil reports, new research, rainfall, pest infestation, root & shoot growth; floral & seed setting, grain/fruit bearing as critical growth factors symptoms and harvest readiness.

The data can be collected at required time intervals either by installing WiFi active hot spot towers as required for entire field coverage.



Precision Agriculture, Smart Farming

- **Precision agriculture** (PA) is an approach to **farm** management that uses information technology (IT) to ensure that crops and soil receive exactly what they need for optimum health and productivity. ... PA is also known as satellite **agriculture**, as-needed **farming** and site-specific crop management (SSCM).

- **Smart farming** is an emerging concept that refers to managing farms using technologies like IoT, robotics, drones and AI to increase the quantity and quality of products while optimizing the human labour required for production.

Among the technologies available to the modern farmers are:

Sensors: soil, water, light, humidity, temperature management

Software: specialized software solutions that target specific farm types or use IoT platforms

Connectivity: cellular, LoRa, *etc*.

Location determiners: GPS, Satellite, *etc*.

Robotics: Autonomous tractors, processing facilities, *etc*.

Data analytics: standalone analytics solutions, data pipelines for downstream solutions, *etc*.

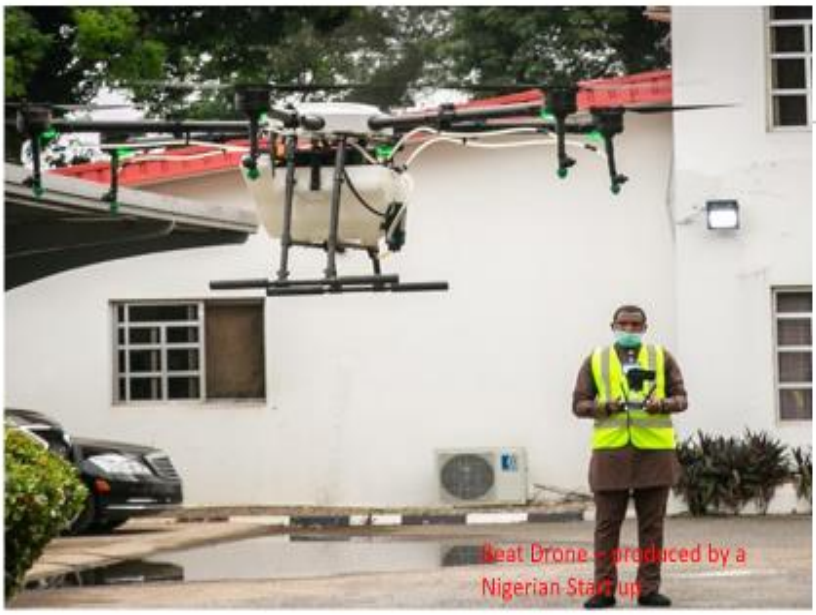
Drones and Remote sensing technology

Drone technology to provide high-quality imaging that can help monitor crops (and animals) while scanning and analysing fields to collect necessary agricultural data. This imaging technology can also assist in the identification of crops and their progress, including their health, and the determination of their readiness **in real-time**

AGRICULTURAL DRONES

Drone technology is giving agriculture a high-tech makeover. Here are six ways drones are used throughout the crop cycle:

- Soil and field analysis / Land management/ Field data collection
- Planting
- Crop spraying / fertilizer application
- Crop monitoring / Surveillance / Health assessment
- Crop yield prediction
- Irrigation: - to identify which parts of a field are dry or need improvement.


Beat Drone – produced by a
Nigerian Start-up


Drone for Spraying Pesticides

Robots in Agriculture

AI companies are focusing much of their efforts on developing autonomous robots that can easily handle multiple agricultural tasks. These robots are capable of ***harvesting crops*** at a much faster pace and higher volume than human workers.

The robots are designed to assist in picking and ***packing crops*** while also combating other challenges within the agricultural labour force.

Additionally, agricultural robots have the ability to ***protect crops from harmful weeds*** that may be resistant to herbicide chemicals that are meant to eliminate them.


ROBOTS ON THE FARMS

Crop Monitoring: monitoring respiration, photosynthetic activity, leaf area index (LAI) and other biological factors.

Pollution Monitoring: measuring carbon dioxide and nitrous oxide emissions so that farmers can reduce their environmental footprint.

Livestock Ranching: used to herd livestock on large ranches, also monitor the animals and ensure they're healthy and have enough area to graze.

Weed Control: can autonomously navigate a farm and deliver targeted sprays of herbicides to eliminate weeds.

Nursery Automation: to move plants around large greenhouses.

Crop Harvesting: can work around the clock for faster harvesting,

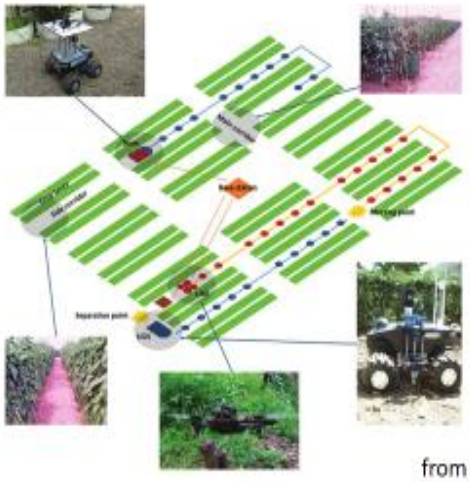
Fruit Harvesting: These field robots are equipped with advanced vision systems to identify fruits and grasp them without damaging them.

Planting and Seeding: field robots with 3D vision systems can now accurately plant


Planting , transplanting

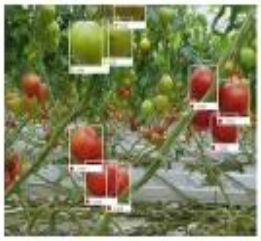
Weeding Robots

Environmental monitoring



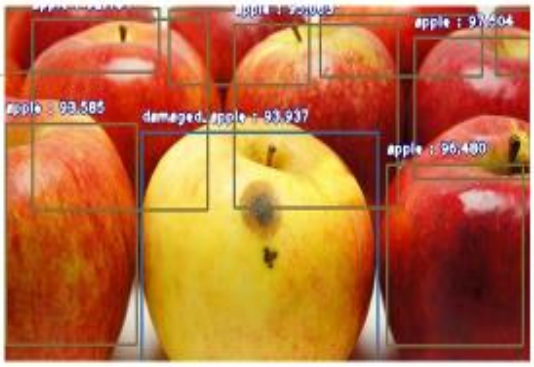
from the book ***Service Robots*** Downloaded from:
http://www.intechopen.com/books/service-robots

Crop Harvesting Robots



Produce and Crop Quality Assessment
We can Choose Crops Ripe For Harvesting

Detect defects



Autonomous Vehicles and Equipment

Land Preparation and Seed planting

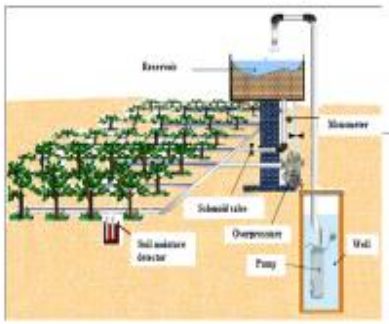
The combination of precision and automation has already made a consequential impact on the job of farming.

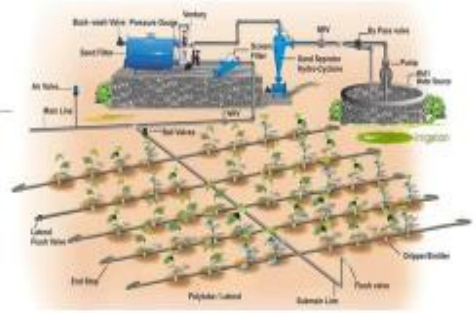
With advanced GPS, a tractor operator can tell which rows have been planted to avoid overlap, making sure every seed is in the right place, with the right depth, soil contact, and spacing that it needs to grow into a food-producing crop.

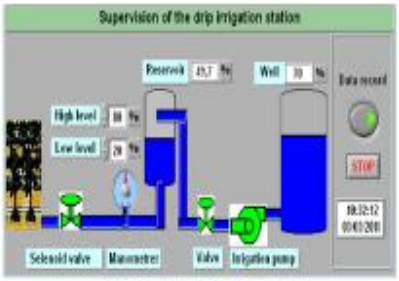
GPS receivers built by John Deere provide navigation accuracy down to one inch.

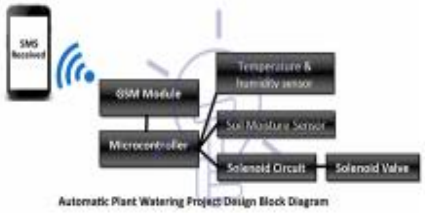
Automated Irrigation

Automatic plant irrigators are planted on the field through wireless technology for drip irrigation. This method ensures effective use of water resources. The technology of smart irrigation is developed, using M2M that is, Machine to Machine technology with the aid of IoT.









Automatic Plant Watering Project Design Block Diagram

https://precisionagricultu.re/autonomous-robots-for-large-scale-agriculture/

AI FOR LIVESTOCK, FISH & POULTRY FARMS

A technique for monitoring the health of farm animals / dairy cattle with a high degree of accuracy uses a camera and artificial intelligence (AI) to achieve a "smart" cow-house.

Detailed observation by AI-powered image analysis could enable early detection of injuries and illnesses that could impact the quantity and quality of milk production.

Facial recognition system that monitors cattle via cameras located on the roof of the barn. The data is then sent to a server on the farm. The main goals are to utilize the data to maximize production and limit stress levels on the cows.

Tackling parasites, biosecurity, and diseases, monitoring farm animal along

AI in Livestock farming

Artificial Intelligence for Health monitoring

Artificial Intelligence for Detection of Oestrus

Robotic System to Deliver Vaccines

Automated milking

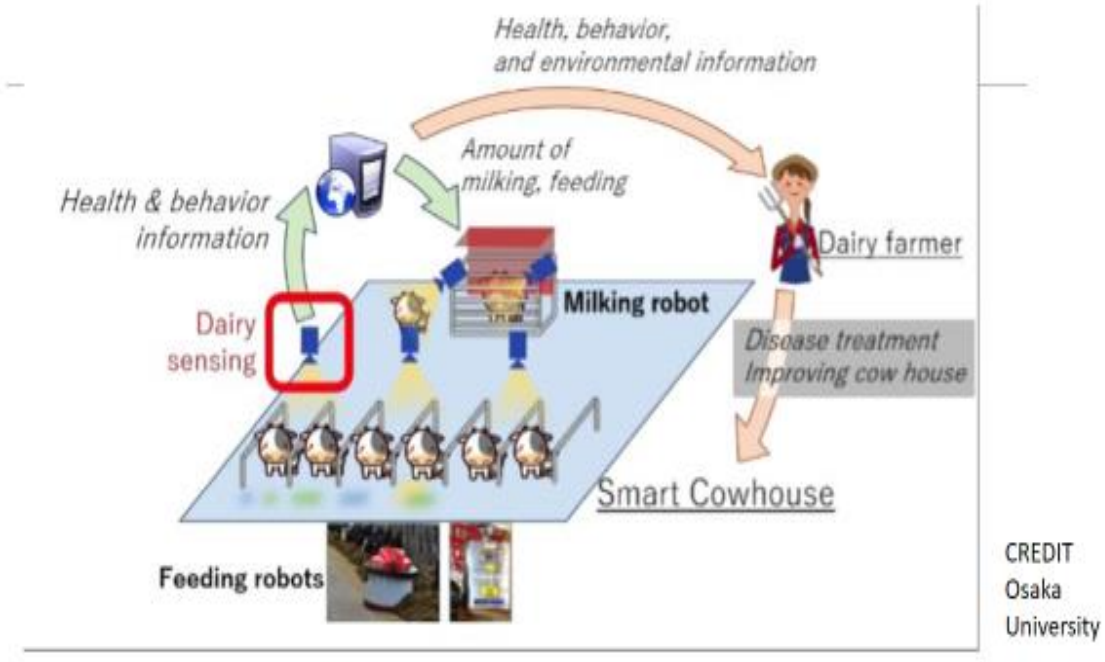
Facial recognition

Detection of bird flu or avian diseases

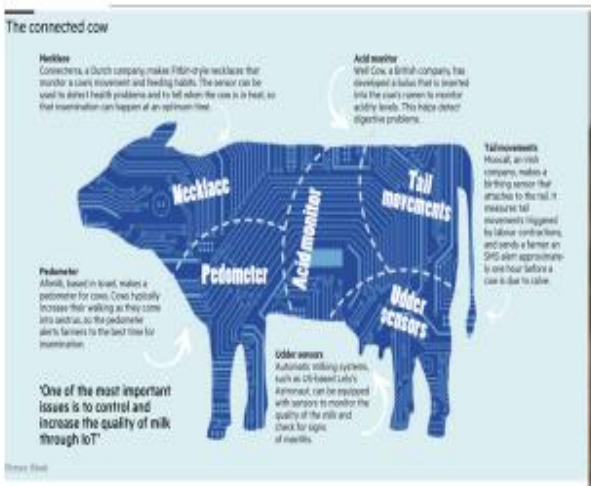
Detection of nutritional deficiencies in chicks.

Detection of Behavioural diseases like cannibalism (or aggressive pecking)


PRECISION
LIVESTOCK
FARMING


Health, behavior,
and environmental information
Amount of
milking, feeding
Health & behavior
information
Dairy farmer
Milking robot
Dairy
sensing
Disease treatment
Improving cow house
Smart Cowhouse
Feeding robots
CREDIT
Osaka
University

Monitoring with sensors



Animal Herding

AI in Crop / Food Processing & Handling

- Sorting
- Food Safety Compliance
- Cleaning
- Non –Destructive tests
- Machine vision & Sensor based quality assessment

Traceability and Supply Chain Management – Block chain technology

It is well known that consumers are increasingly becoming interested in where their food comes from and how it is produced. Blockchain can connect all aspects of the supply chain from producer to consumer and allow for food traceability and safety.

From an agriculture and food perspective, offering this type of information to consumers will become a competitive advantage.

Conclusions

Artificial intelligence is the future of farming , but unfortunately, it also has some challenges on its back. This is why the new and existing players in the global AI technology market will need the customary assurances before taking the leap into the agricultural sector. With drones, robots and intelligent monitoring systems now successfully being used , artificial intelligence, or machine learning, is set to revolutionise the future of farming as the next phase of 'ultra-precision' livestock farming is on the horizon.

Cloud Computing In Agriculture: The Future of Food Security for Developing Economy

Cloud Computing In Agriculture: The Future of Food Security For Developing Economy

Engr. John Audu (PhD)
MCOREN, MASABE
B.Eng (Maiduguri), M.Eng (Makurdi), PhD (Ibadan)

Federal University of Agriculture, Makurdi, NG

Chairman, webinar organizing committee.
(CIGR Artificial Intelligence Africa section)

Areas of Expertise

- ✓**Crop processing and storage automation**
- ✓**Modeling , Optimization and Simulation**
- ✓**Computer Vision**
- ✓**Artificial Intelligence and Machine Learning**
- ✓**Robotics**
- ✓**Internet of things (IOT)**
- ✓**Industrial Internet of things (IIOT)**
- ✓**Drones**
- ✓**Cloud computing and Block chain Technology**

Presentation Outline

- Introduction to cloud computing
- Cloud computing software and vendors (Providers)
- Application of cloud computing in Agriculture
- How Cloud computing is changing the face of Agriculture in developing economy

Introduction to cloud computing

Computing is the process of using computer technology to complete a given goal-oriented task

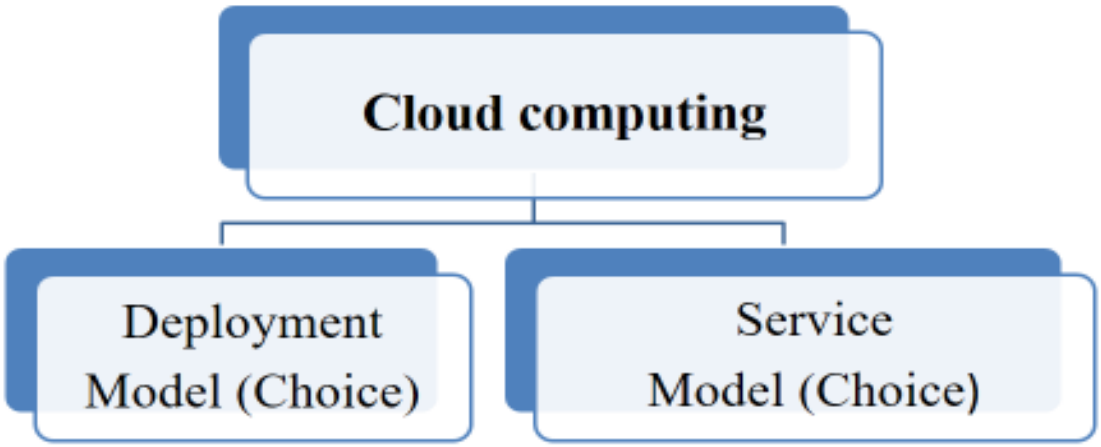
"The cloud" refers to servers that are accessed over the Internet, and the software and databases that run on those servers..

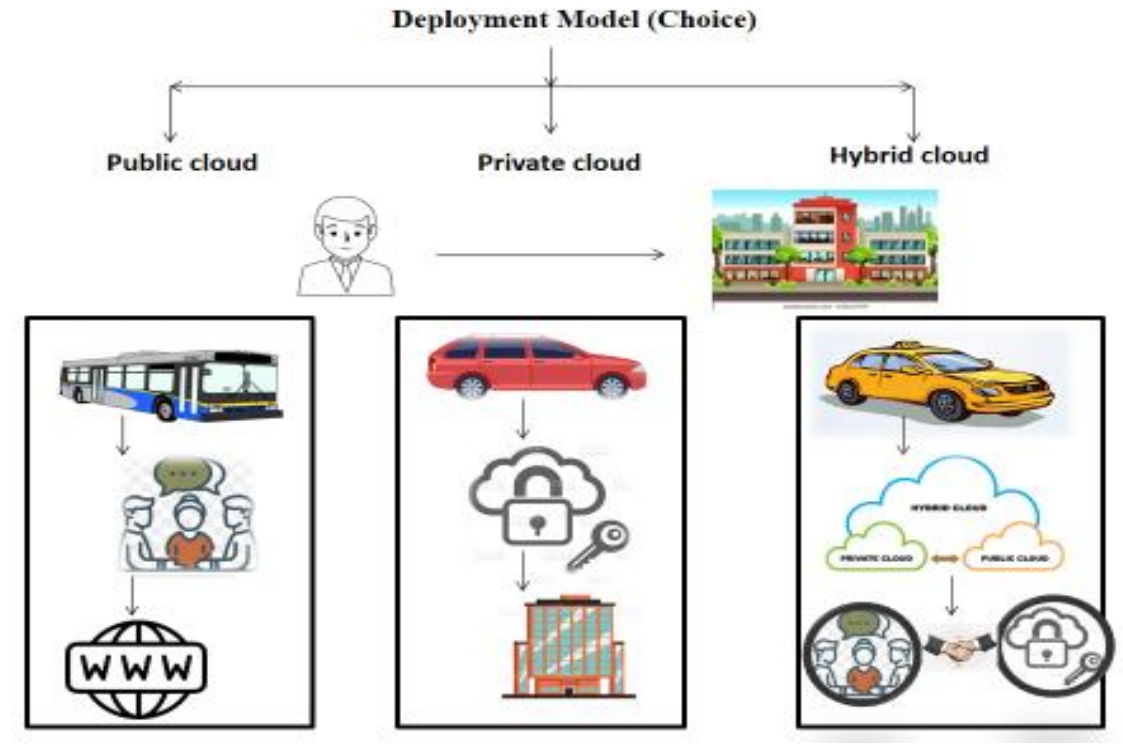
Cloud computing is the delivery of computing services — including servers, storage, databases, networking, software, analytics, and intelligence —over the Internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale.

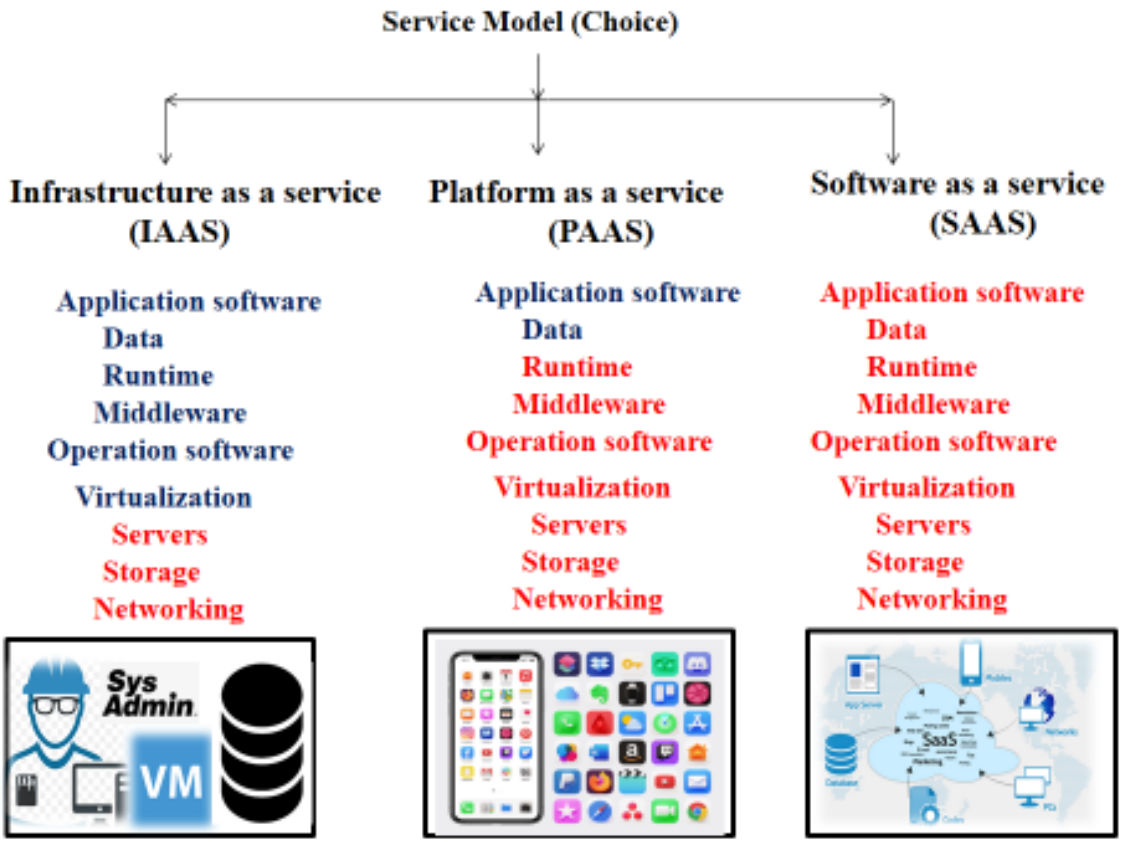
Benefits of cloud computing

- Cost - Eliminates the capital expense
- Global scale - computing power, storage, bandwidth
- Performance – upgraded secure datacenters
- Speed – Service provision in minutes
- Productivity – Remove IT management chores.
- Reliability - Makes data backup & disaster recovery
- Collaboration - Exposed to the same infrastructure
- Security – Protect potential threats

Choosing cloud computing system to use




Deployment Model (Choice)
Public cloud
Private cloud
Hybrid cloud
WWW


Service Model (Choice)
Infrastructure as a service (IAAS)
Application software
Data
Runtime
Middleware
Operation software
Virtualization
Servers
Storage
Networking
Sys Admin
VM
Platform as a service (PAAS)
Application software
Data
Runtime
Middleware
Operation software
Virtualization
Servers
Storage
Networking
Software as a service (SAAS)
Application software
Data
Runtime
Middleware
Operation software
Virtualization
Servers
Storage
Networking
SaaS

Cloud computing software and vendors (providers)

Top 10 cloud service providers in 2021

Amazon Web Services (AWS)

Launched in 2002
Most popular
Over 165 features

Virtual Private Cloud
AWS Data Transfer
Simple Storage Service
DynamoDB
Elastic Compute Cloud
AWS Key Management
Service, Amazon Cloud Watch
Simple Notification Service
Relational Database Service
Route 53
Simple Queue Service
CloudTrail
Simple Email Service.

Microsoft Azure

Launched in 2010
Over 100 features

Azure AD
HockeyApp
SDK APIs
SMB protocol.
Azure Data Explorer
Cosmos DB
StorSimple
Azure Stream Analytics
Event Hubs
Azure DevOps
Azure Blockchain
Workbench
Azure IoT Hub
Azure IoT Edge

Google Cloud

Launched in 2008
Over 100 features

MySQL
VPC - Virtual Private Cloud
Apache Airflow
Trifacta
Cloud AutoML
Cloud Vision API
Cloud Shell
Cloud APIs
OpenID
Cloud IoT Core
Cloud IoT Edge
Maps Platform
API Analytics
API Monetization

Alibaba Cloud

Launched in 2009
Over 200 features

Elastic Compute Service
Container Registry
Object Storage Service
Network Attached
Storage
Virtual private cloud
VPN Gateway
ApsaraDB for Redis
AnalyticDB for MySQL
Cloud Firewall
Security Center
Cloud Web Hosting
Image Search
Intelligent Robot
Blockchain as a Service
AliwareMQ for IoT

IBM Cloud

Launched in 2011
393 features

Analytics Engine
API Connect
App ID
AT&T IoT Data
Bitbar Testing
Blockchain Platform
Bosch IoT Rollouts
Cloud for Education
Cloud Migration
Container Registry
IBM Cloud Functions
IoT Platform
Machine Learning
Quovo
SQL Query
GeneXus

Oracle Cloud

Launched in 2016
more than 80

Virtual Machine
GPU servers
Data storage
Apache Spark
OLTP
Data warehousing
Oracle DBMS
NoSQL
Oracle Exadata
Equinix
API platform
Content platform
Security platform
Apps Dev platform
Integration platform

Salesforce

Launched in 1999
360 features

CRM tool
Salesforce IQ
Salesforce CPQ
Salesforce Data.com
Salesforce Engage
Salesforce DMP
Social Studio
Interaction Studio
Salesforce Lightning
Heroku
mySalesforce
myEinstein
Salesforce Shield
Salesforce IoT Cloud
Salesforce Identity
Salesforce Bolt

Alibaba Cloud

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Over 200 features

- Elastic Compute Service
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- CRM tool
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- Salesforce DMP
- Social Studio
- Interaction Studio
- Salesforce Lightning
- Heroku
- mySalesforce
- myEinstein
- Salesforce Shield
- Salesforce IoT Cloud
- Salesforce Identity
- Salesforce Bolt

Application of cloud computing in Agriculture

Farmers data

FARMERID

Farmers connect

Developed in 2019

Switzerland

Mobile SaaS

Farmer connect Paas

Farmers personal record

Farmers Business records

Co-operatives membership

Data for insurance

Data for loan facilities

Data for Agric. merchants

Farmers control their data

Farm Registration

APEDA & India Govt.

Developed in 2020

India

Mobile SaaS

Government data base

Farmers personal record

Farmers Business records

Co-operatives membership

Data for insurance

Data for loan facilities

Cloud farmer

MEA Mobile Ltd

Developed in 2016

Connecticut, USA

Mobile SaaS

Famers' record app

Recording information

Whether online or offline

Planner & stock records

Farm diary &time sheets

Purchases and sales

Health & safety of animals

Farm jobs list

Farm Management

iSOYLscout

By SOYL Company
Developed in 1993
United Kindom
Mobile SaaS
MySOYL cloud Paas
Record field problems
Monitoring field problems
Review field problems
Inbuilt GPS
Record crop performance
Weed infestations
Data storage

Agrivi

Agrivi company
Developed in 2016
London, UK
Mobile SaaS
Agrivi cloud Paas
Farm Management
Weather Monitoring
Pest Detection
Farm Economics
Resources & Inventory
Growth Analytics
Growth reports

AgDNA

AgDNA company
Developed in 2012
California, USA
Mobile SaaS
AgDNA cloud Paas
Farm planning
Record keeping
Boundary mapping
Worked area mapping
GPS equipment mapping
Tracking and scouting
Remote sensing
Data sharing

Crop management

FarmLogs

By FarmLogs Company
Developed in 2012
Michigan, USA
Mobile SaaS
FarmLogs cloud Paas
Yield threats notifications
Track field activities
Soil nutrients maps
Monitor field rainfall
Crop heat accumulation
Performance yield maps
Plan seasonal inputs
View crop growth stages

Pioneer Field 360 Note

By DuPont Pioneer
Developed in 2013
Iowa, USA
Mobile SaaS
Pioneer Field360 Paas
Crop analysis tools
Real-time data inputs
GDU calculator
Precipitation forecasts
Crop progress view
Growth Stage Estimator

ID Weeds

University of Missouri
Developed in 2016
Missouri, USA
Mobile SaaS
Search for weeds
Weeds Latin names
View list of weeds
Identify weeds
Weeds photograph
List of suspected weeds
Identify unknown species

Animal management

NUBeef-BCS

University of Nebraska
Developed in 2013
Nebraska-Lincoln, USA
Mobile SaaS
Beef producers
Managing nutrition
Body Condition Scoring
Relative fatness
Herd accessibility
Health condition
Tagging system

Farmeron

By Farmeron Inc.
Developed in 2010
California, USA
Mobile SaaS
Farmeron cloud Paas
Calf management
Health Management
Fertility management
Culling management
Dairy Protocols

Grass2Milk

By OneFarm
Developed in 2014
Ireland.
Mobile SaaS
Animal information
Prediction
Built in GPS
Health condition
Managing nutrition
Tagging system

Soil Information

SoilWeb

University of California
Developed in 2010
USDA, USA
Mobile SaaS
Soilweb cloud Paas
Interactive Google map
3-D Soil survey data
Soil types nationwide
Soil properties
Identify suitability
Groundwater recharge

Crop Water

University of Nebraska
Developed in 2012
Nebraska, USA
Mobile SaaS
Irrigation app
Estimate soil water status
Inputs from soil sensors
Estimate soil water used
Check available soil water
Sensor readings graph

PureSense

PureSense Inc.
Developed in 2014
USA
Mobile SaaS
PureSense cloud Paas
Irrigation app
Irrigation schedules
Irrigation reports
Monitoring stations
Soil moisture conditions
Summary irrigation charts

Agricultural Land

ScoutDoc

By AgNition Company
Developed in 2012
Ontario, Canada
Mobile SaaS
Field scouting app
Collect field information
Tracking sites visits
Field crop conditions
Document weeds
Field diseases and insects
Images of Field maps
Store field information

Farm and Land Realty

Farm and Land Realty
Developed in 2021
Pennsylvania, USA
Mobile SaaS
Agricultural land services
Connect buyers and sellers
Sell farm properties
Help to find farm land
Search farm vacant land
Find farm land developers
Find conservation land

GPS Fields Area Measure

Farmis
Developed in 2009
Kaunas, Lithuania
Mobile SaaS
FARMIS cloud Paas
Measure farm lands
Fast area marking
Accurate pin placement
Edit measurements
GPS tracking
Auto measure boundaries

Insect and pest

RRXtend Spray

Bayer Group
Developed in 2018
Missouri, USA
Mobile SaaS
RRXtend Spray Paas
Spray plan
Weather forecasts
Risk forecast tool
Create application record
Tank mixes and nozzles
Educational videos
Google map

AgVault 2.0 Mobile

Sentera LLC Countries
Developed in 2016
US, Canada, UK etc
Mobile SaaS
Sentera AgVault Paas
Crop scouting
Autonomous-flight tool
Track crop growth stages
Track Storm damage
Detect Pest infestation
Identify Weed types
Track farm equipment
Capture farm imagery

NPIPM Soybean Guide

South Dakota State University
Developed in 2011
South Dakota, US
Mobile SaaS
Soybean pest guide app
Insect Management
Arthropod management
Soybean pathogens

Fertilizer and pesticide

Yara Pure Nutrient

Yara International
Developed in 2016
Norway
Mobile SaaS
Yara cloud Paas
Mineral fertilizers
Application precision
Efficiency and reliability
Compare nitrates / urea
Optimize crop yield
Environmental impact
Application cost

Mix Tank

Precision Laboratories
Developed in 2011
Illinois, USA
Mobile SaaS
Tank mixing sequence
Product use rates
Application information
Spray Logs
Weather features
Product use rates
Feedback

Pesticides & Alternatives

Iseal Alliance
Developed in 2019
Isreal
Mobile SaaS
Decision-making app
Access to toxicity infor.
Support pest control
700 pesticide ingredients
All registered pesticides
2700 pests and diseases
Multi-lingual user interface

Agricultural marketing

AGSentry

HD Precision Analytics
Developed in 2016
Missouri, USA
Mobile SaaS
Retailers and dealers app
Smart trade analysis
highlights critical trends
Improves sales focus
High customer retention
Aligns marketing & sales
High efficiency / accuracy
Resolve sales barriers

Farmers e market

Tata Trust & India Govt
Developed in 2021
Kerala, India,
Mobile SaaS
Website & mobile app
Display & sell products
Sell & buy machinery
Farm Inventions
E-payment services
Sell & buy agric. books
Subscribe periodicals
Advice and services

ThankMyFarmer

Farmers connect
Developed in 2019
Switzerland
Mobile SaaS
Farmer connect Paas
Display & sell products
Sell & buy machinery
Create and publish brand
Traceability maps
Product origins
Donations to farmers
Advice and services

Weather

Climate FieldView

By Climate Corporation
Developed in 2015
San Francisco, CA, USA
Mobile SaaS
Local weather monitoring
Agronomic modeling
Weather simulations
Current field weather
Capture location photos
Daily weather alerts
Monitor nitrogen levels
Field health levels

FarmHedge.io

By Farm Hedge Org.
Developed in 2015
Ireland
Mobile SaaS
Weather forecast
Current field weather
Weather Alerts
Booking Inputs Alert
Inputs application Alert

Fresh Air Weather

By Lucy Gillian Kuyan
Developed in 2015
Mobile SaaS
Weather radar map
Climatic conditions
Weather graph
Weather warnings
Weather Calendar
Daily notifications
Schedule weather

Agricultural Disaster Management

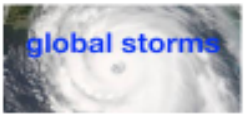
AgroSim

Business Simulations
Developed in 2012
Biscay, Spain
Mobile SaaS
Simulator app
Decision-making tool
Development scenarios
Management scenarios
Climatic awareness
Price change awareness
Raw materials availability
Economic status

Hurricane

American Red Cross
Developed in 2013
USA
Mobile SaaS
Risk Planning app
Storms forecast & history
Create an emergency plan
Tips and instructions
Location notifications
Alert approaching storm
Indicate high risk areas

Global storms



Kelly Technology Inc.
Developed in 2010
Arizona,USA
Mobile SaaS
Hurricanes and typhoons
Global satellite views
Radiation monitor
Ultraviolet index
Global climate imagery
Space weather
Animated forecast chart

Expert Consultation

AgriSync

John Deere & Company
Developed in 2014
Illinois, USA
Mobile SaaS
Link farmer to advisor
Resolve support issues
Link to Multiple advisors
Video conversation
Multiple famer service
See farmers feedback
Web dashboard

ConnectHub

connecthub

By Farmers connect
Developed in 2019
Switzerland
Mobile SaaS
Farmer connect Paas
Farmer to the consumer
Farmer to professionals
Blockchain Data sharing
Supply chain partners
Farmer and aggregators
Farmer and processors

AgriApp

AgriApp

AgriApp Pvt Ltd
Developed in 2016
Karnataka, India
Mobile SaaS
AgriApp cloud Paas
Services & consultation
Crop Production
Crop Protection
smart farming
e-Commerce
Farmer to the consumer
Farmer to professionals

Agricultural Awareness (News)

Grower's Edge

By Grower's Edge Inc.
Developed in 2016
Iowa, USA
Mobile SaaS
Grower's Edge Paas
Cash Bids
Corn Prices
Soybean Prices
Market Commentary
Weather
Agricultural News
Markets and stocks

CHS Grain Trading

CHS Grain Trading

By CHS Inc.
Developed in 2013
South Dakota, USA
Mobile SaaS
DTN Portal Paas
Cash Bids
Sale Offers
Monitor updating prices
Markets trading
Update target price
View Contracts traded

Profi – Farm Machinery

profi Tablet edition

By Landwirtschaftsverlag
Developed in 2016
England
Mobile SaaS
Tractor and machinery
Contractors
Machinery dealers
industry leaders
Expert knowledge
Operational advice
Maintenance and repair

How Cloud computing is changing the face of Agriculture in developing economy

What is Food Security?

Food security means having, at all times, both physical and economic access to sufficient food to meet dietary needs for a productive and healthy life.

A family is food secure when its members do not live in hunger or fear of hunger.

United States Agency for International Development , (USAID).

Kenya

14 Agricultural cloud Apps

iCow-the winning application in the Apps for Africa Competition 2010 allows small-scale dairy farmers to manage and trade livestock. The platform has allowed users to increase milk production by over 50% and income by 42%.

M-Farm - a real-time group buying and selling market for farmers launched in 2010.

Kilimo Salama - enables smallholder farmers to insure their agricultural inputs against adverse weather conditions.

KUZA Doctor, 'a farmer's mobile toolkit from farm to fork', provides knowledge to farmers using SMS.

SALI (Sustainable Agricultural Livelihood Innovation) done in Mbeere, Embu by Christian Aid, uses mobile phone technology to notify farmers of weather updates.

Farming App kenya - livestock & crop farming ebook. Designed to provide vital information for crops and livestock farmers. Farmers will learn about seeds selection, pests and diseases control, basic farm management and record keeping.

VetAfrica is a mobile application developed to help **African vets** and farmers diagnose diseases in livestock. It has been developed by Scottish based company

Cameroon:

Agro-Hub uses mobile technology to drive demand for farmers' products, attract better prices, and increase farmers' income.

South Africa:

SANGONeT is involved with an application that allows small-scale dairy farmers in East Africa to record the lactation history of their cows.

GreenFingers Mobile - Smallholder farming app. Manage and finance large groups of smallholder farmers. manage farmer profiles, track commercial exchanges, monitor field extension staff, and ensure that effective and timely technical assistance is provided in the field.

Rwanda

AgriGO App - Designed to enable small scale farmers accessing latest actionable farming techniques through Mobile, from vetted agronomists while using the mobile phone to keep recording and monitoring the production costs.

Democratic Republic of Congo

Mobile Agribiz is a web and SMS mobile application that helps farmers decide when and how to plant crops, and how to select the best crops

Ghana

The **Esoko** app service allows farmers access to market prices and allows them to place buy/sell orders.

CocoaLink launched by the Ghana Cocoa Board, Hershey, and World Cocoa Foundation, connects cocoa farmers with information about good farming practices. The free service uses SMS and voice.

Farmers in the in the Eastern Corridor of the Northern Region are able to get better prices for their crops by using text messages thanks to the **ECAMIC project** app

Uganda:

Infotrade is a platform built to integrate collection, analysis and dissemination of agricultural and other market information.

Mayuge Farmers Exchange provides farmers with access to email communication and information for learning best practice farming.

Zimbabwe:

Zimbabweans can buy and sell cattle online thanks to the **Remote Livestock Marketing System.**

Nigeria

AgroDomain is an integrated end-to-end Pan African Agro Marketplace Platform

THE MARKETPLACE
AGRO ONLINE STORES
AGRO FUNDER
AGRO INSURANCE HUB
AGRO CO-OPERATIVES SYSTEM
AGRO TRUCKER
AGRO NETWORKS
AGRO PAY

Ga'atevest is the online investment platform offered by the Nigeria Farmers' Group & Cooperative Society, Nigeria's premier Agricultural Investment Platform.

Hello Tractor **Releaf.NG**
ProbityFarms **Cellulant.**
FarmCrowdy **VoguePay.**
Compare-The-Market

Philippines

Krops is a mobile application for Agricultural E-Commerce. You can buy, sell and scout for Farm produce from your device.

West Indies

Mobile Fisheries, "**mFisheries**", presents a channel for the integration of technology-excluded small scale fisherfolk into the global information society

Top Ten Cloud computing companies in Nigeria

- Cloudflex computer services limited - **Lagos**
- Cybercloud Platform limited - **Lagos**
- Layer3cloud - **Abuja**
- Velvot Nigeria Limited - **Lagos**
- Descasio Limited - **Lagos**
- Nobus cloud services - **Lagos**
- MDX-i - **Abuja**
- Linx Networks - **Abuja**
- Cloudware technologies - **Ibadan**
- Metronet - **Abuja**

Conclusion

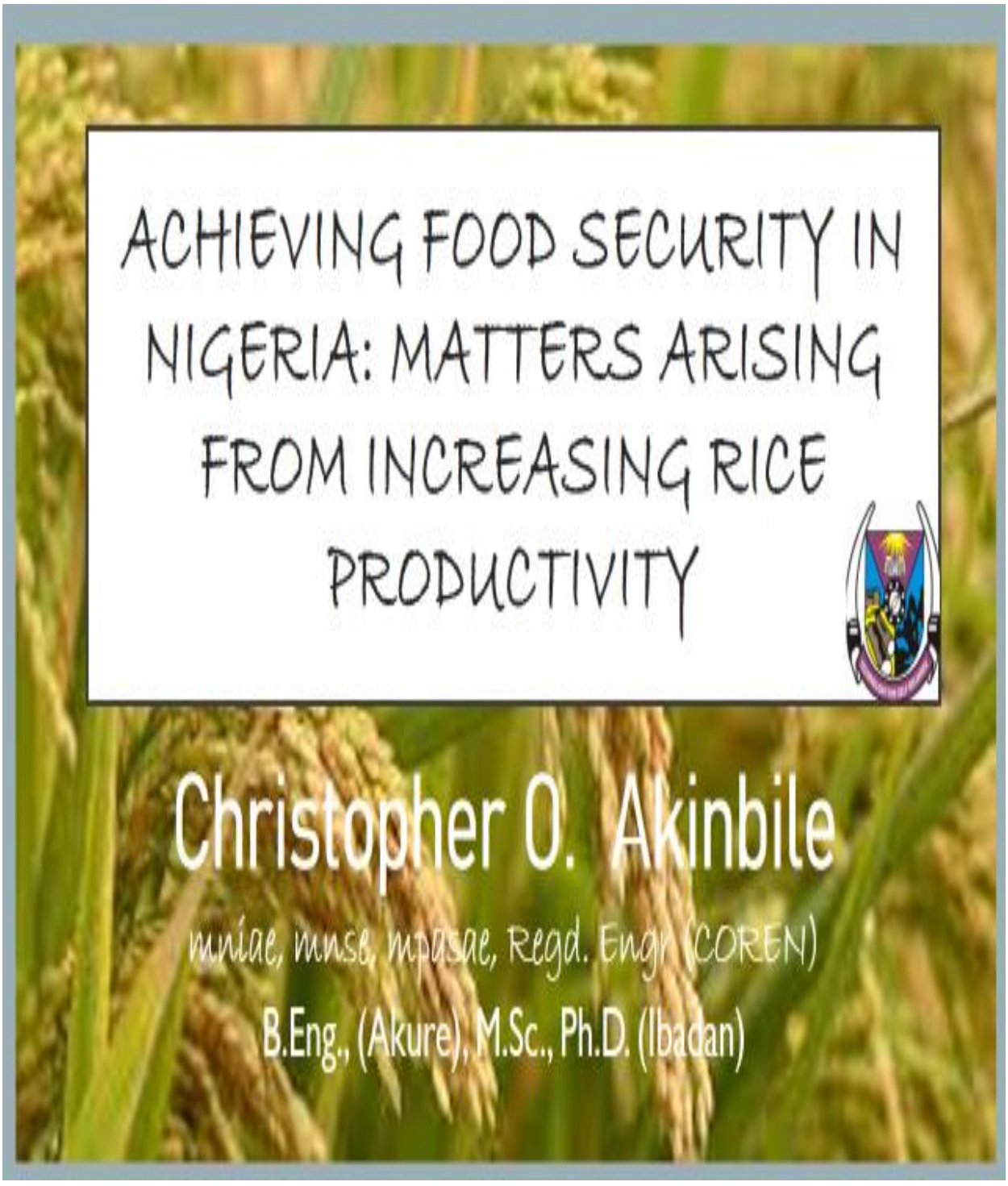
- **Cloud computing can connect small scale farmers and medium scale entrepreneurs to the big markets**

- **Cloud computing can provide information on status of food availability in developing economy. Hence, provide the foundation for food security policies.**

- **Cloud computing can take digital agriculture to small scale farmers.**

Thanks

Achieving Food Security in Nigeria: matter arising from increasing rice productivity

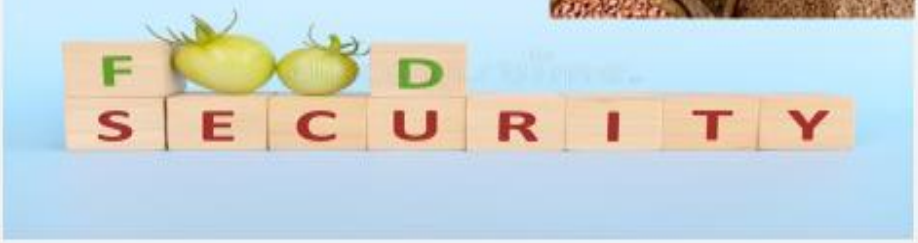

ACHIEVING FOOD SECURITY IN NIGERIA: MATTERS ARISING FROM INCREASING RICE PRODUCTIVITY
Christopher O. Akinbile
mniae, mnse, mpasae, Regd. Engr (COREN)
B.Eng., (Akure), M.Sc., Ph.D. (Ibadan)

Outline..

- ✓ Food Security
- ✓ Food Insecurity
- ✓ Implications of food insecurity
- ✓ Facts check on Nigeria
- ✓ Rice- a critical crop in achieving food security
- ✓ Why Rice?
- ✓ Global production statistics
- ✓ How far so far? – Matters arising
- ✓ Challenges of rice production in Nigeria
- ✓ Nigeria's Rice history in the last 5 years
- ✓ the way forward
- ✓ Conclusion
- ✓ Appreciation

Food Security

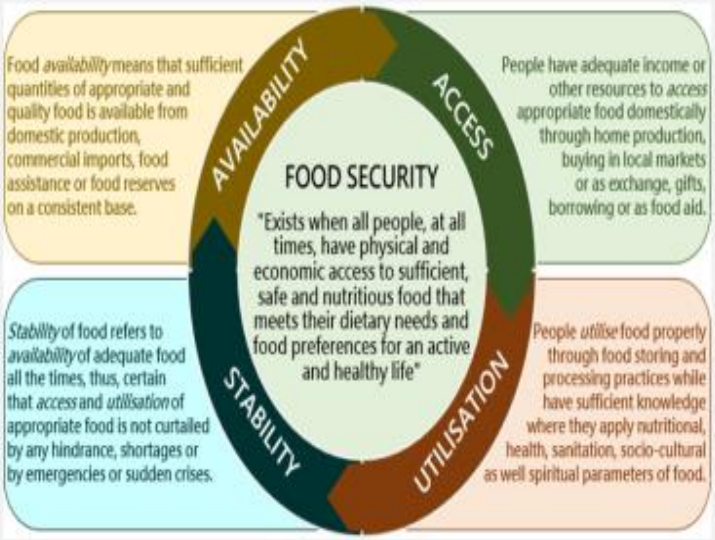
- Food security is defined as meaning that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life. The United Nations' Committee on World Food Security.
- The term "food security" was defined with an emphasis on supply; food security is defined as the "availability at all times of adequate, nourishing, diverse, balanced and moderate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices"
- Food security incorporates a measure of resilience to future disruption or unavailability of critical food supply due to various risk factors including droughts, shipping disruptions, fuel shortages, economic instability, and wars.



Food Security Cont'd

Four pillars of food security

- availability, access,
- utilization, stability.



Implications Of Food Insecurity

- Scarcity, shortages and famine – soaring food prices, 'food' war
- Displacement –IDPs
- Migration, resettlement and relocation
- Agitation and political instability occasioned by demonstration – Sri Lanka
- Banditry and insecurity – Northern part of Nigeria, Afghanistan
- Conflicts
- Inter and intra tribal conflicts
- Transboundary conflicts – Russian-Ukraine war ripple effects on global food security

Facts Check on Nigeria

60% -of people nationwide live below the poverty line

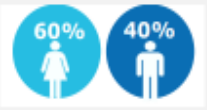
Over 2 million -people internally displaced in Borno, Yobe and Adamawa states

6,024 mt of food assistance distributed

USD 4.27 m in cash-based transfers made

USD 172 m six-month net funding requirement (June 2022 to November 2022)

679,117 people assisted in May 2022



WFP World Food Programme

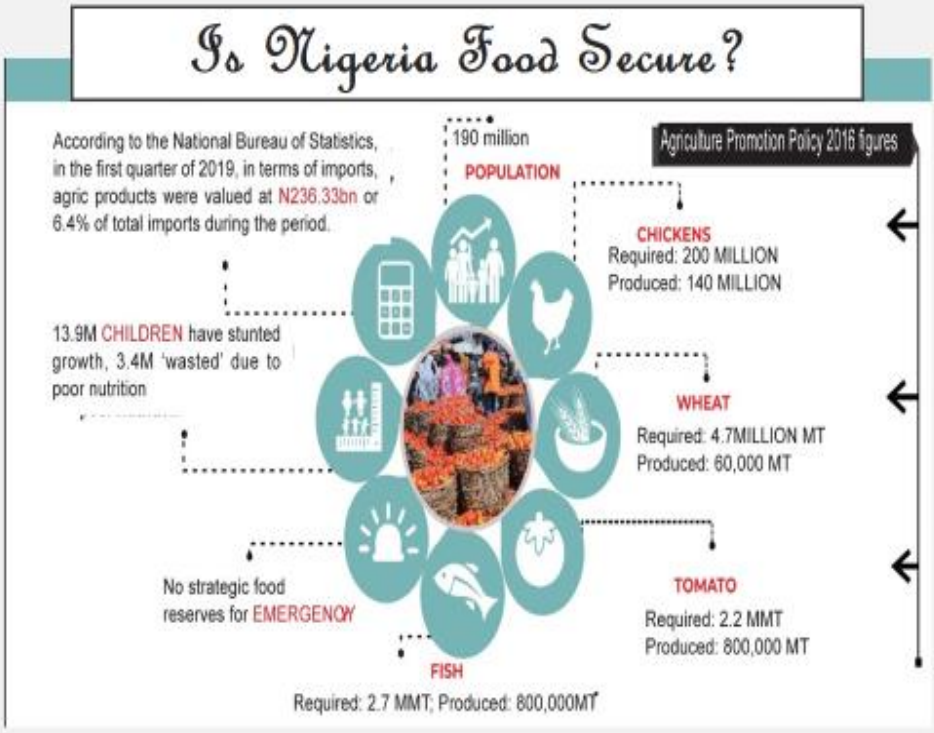
WFP Nigeria Country Brief
May 2022

www.wfp.org/countries/nigeria

Top 20 largest countries by population

1	China	1,450,891,670	11	Japan	125,683,434
2	India	1,408,638,688	12	Ethiopia	121,190,849
3	U.S.A.	335,061,271	13	Philippines	112,684,464
4	Indonesia	279,638,482	14	Egypt	106,495,660
5	Pakistan	230,151,808	15	Vietnam	99,183,361
6	Brazil	215,728,039	16	D.R. Congo	95,598,382
7	Nigeria	217,312,769	17	Turkey	86,258,569
8	Bangladesh	168,153,243	18	Iran	86,277,733
9	Russia	146,063,666	19	Germany	84,340,660
10	Mexico	131,796,184	20	Thailand	70,163,365

http://www.worldometers.info/world-population/



Matters Arising: 2022 National Budget

Table 1: 2022 National Budget

SN	Sectoral allocation	Value (in trillion)	Percentage (%)	Ranking
1	Defense & Security	2.41	15	1st
2	Infrastructure	1.45	8.9	2nd
3	Education	1.29	7.9	3rd
4	Social development and poverty eradication	863 billion	5.3	4th
5	Health	820 billion	5.0	5th
	Agriculture	291.5 billion	1.8	11th

TOTAL PROPOSED FIGURE: N16.39 trillion

Is Nigeria Food Secure cont'd ?

The national average yield of cereal crops is a mere 1.2 tons/ha against the potential yield of 8 – 12 tons/ha. An example, the average yields of maize and rice are 1.64 tons/ha and 2.0 tons/ha against the potential yields of 10 tons/ha and 12 tons/ha, respectively

Even cassava, the crop which Nigeria is reported to be the leading country in the world for its production has an average yield of 13 tons/ha against the potential yield of 60 tons/ha.

In the 2022 budget, only N291.4 billion (1.8 per cent) is for the agricultural sector. This includes N71.6 billion for personnel cost, N 3.7 billion for overhead and N215.8 billion for capital expenditure.

The Maputo Declaration came during the second ordinary assembly of the African Union in July 2003 in Maputo, Mozambique, when African heads of state and government met.

Through the declaration, the African Union (AU) enclosed several important decisions regarding agriculture, but the crucial among them was the commitment to the allocation of at least 10 % of its annual national budget to agriculture and ensure the growth of the agricultural output of at least six per cent annually.

Table 2: Nigeria's budgetary allocation to Agriculture 2001-2022

SN	Year	Percentage relative to total budget
1	2022	1.8
2	2021	1.4
3	2020	1.3
4	2019	1.6
5	2018	2.0
6	2017	1.7
7	2016	1.3
8	2015	0.9
9	2014	1.4
10	2013	1.7
11	2012	1.6
12	2011	1.8
13	2009	5.4
14	2008	5.4
15	2007	3.4
16	2001	1.3

National budget for Agriculture N291,466,466,723

Budgetary Allocation To Defense

Facts Check on Nigeria Cont'd

8.7 million -people are food insecure in northeast Nigeria

Rice- A Critical Crop For Achieving Food Security

Why Rice?

Globally, rice ranks third after wheat and maize in terms of production and in Nigeria, is the sixth major crop in cultivated land area after sorghum, millet, cowpea, cassava and yam (Akinbile, 2013).

Rice is one of the few crops grown nationwide and in all agro ecological zones from Sahel to the coastal swamps.

It contributes over 20% of its total calories intake of the human population
As population increases over this century, the demand for rice will grow to an estimated 2000 million metric tons by 2030 (FAO, 2007)

Rice is produced in at least 95 countries across the globe and provides a staple food for more than half of the world's current population

Nigeria is the largest producer of rice in West Africa producing over 46% of the regions total production (Singh et al., 1997) and

It the only crop that can be grown in all the agro-ecological zones of the country.

Global Rice Production

Table 3: Ten Largest Rice-Producing Countries

Rank	Country	Rice production in million metric tonnes in 2018/19
1	China	148.5
2	India	116.42
3	Indonesia	36.70
4	Bangladesh	34.91
5	Vietnam	27.77
6	Thailand	20.34
7	Burma	13.2
8	Philippines	11.73
9	Japan	7.66
10	Brazil	7.14

Table 4: Top five rice producing countries in 2020/2021

SN	Countries	Tonnes per year	Position
1	China	211,405,211	1st
2	India	177,645,000	2nd
3	Indonesia	38,132,157	3rd
4	Bangladesh	36, 231,455	4th
5	Vietnam	29,980,002	5th

Current global production = 755,473,800 tonnes per year

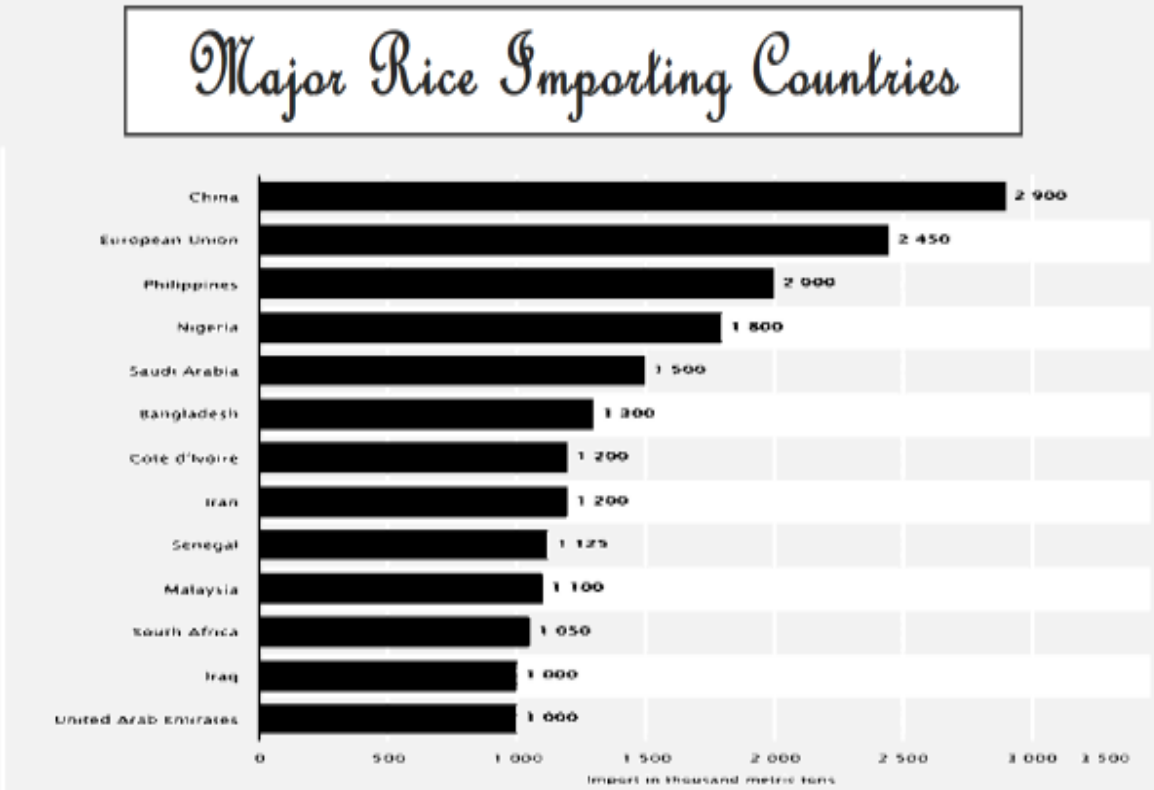


Figure 1: Top 13 major rice importing countries in the world Source: Shahbandeh (2021)

Matters Arising

.....January 18, 2022 in Abuja, Nigeria

Nigeria's Rice History In The Last 5 Years

Table 6: Nigeria's rice production level so far

Year	Rice imports (MMTs)	Rice production (MMTs)	Rice consumption (MMTs)
2017/2018	2.1	4.47	6.75
2018/2019	1.8	4.53	6.80
2019/2020	1.8	5.04	6.85
2020/2021	1.9	4.89	6.90
2021/2022	2.0	5.00	6.95

Specifically, the country's consumption of 6.95 (almost 7.0) million metric tonnes and production of 5.000MMTs leave a deficit of approximately 2.00 million metric tonnes

Challenges of Rice production in Nigeria

- **Deliberate and artificial scarcity** - *"some middlemen and millers usually mop up rice paddies and keep them in warehouses," creating scarcity, and causing hikes in the price".*
- **Excellent agricultural policies but bad implementation** – Agricultural Transformation agenda (ATA), the Anchor Borrowers' Programme (ABP), Agriculture Promotion Policy (APP), Zero reject initiative, the LIFE Programme, APPEALS project
- **Policy somersault**
- **Over-dependent on importation** – dietary preferences on imported commodity at the expense of those produced locally
- **Insufficient local production resulting in food insecurity**
- **Insufficient land under cultivation**
- **Under-utilization of natural resources e.g. land, water etc**
- **Conflict, kidnapping and banditry especially in the northwes and northcentral states**
- **Inflation and high cost of production** -Inflation as of March 202 driven by a hike in food prices, reached 15.92%, from 15.70 recorded in February

Rice Status In Nigeria Today

Price Survey

-A 50-kg bag of locally processed premium rice is between N35, 000 in most supermarkets and rice depots

-The lowest price is about N27, 500, mostly processed and packaged by emerging small to medium-scale factories.

-Brands of rice from integrated rice mills cost between N28, 000 and N35, 000, but they are comparable with polished foreign rice.

Information On Milling and Annual Milling Capacity

Mills and milling capacity per year - Nigeria

40 medium-scale to large-scale rice mills currently operate in the country.

40 mills is between 2.0 and 2.5 million metric tonnes of rice.

Small-scale and cottage rice mills are responsible for about 2.5 million metric tonnes as the country produces 5.0 million metric tonnes of milled rice per year based on the report by USDA

This is in contrast to the Federal Government's position which reported that as of January 2022, there were over 68 integrated mills with a combined capacity of 3.0 million metric tonnes

The Way

Way Forward

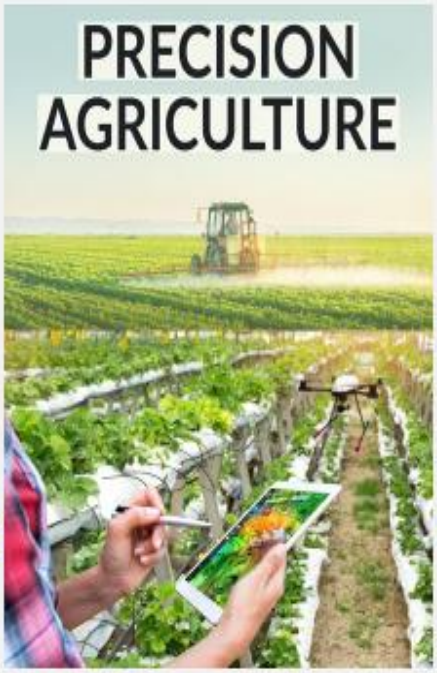
1. Increase Land under cultivation

- Mechanized Agriculture
- Although rice cultivation increases annually, it has not been able to meet local demands
- To be food secure, increase land under cultivation
- Rice could be cultivated in about 4.6 to 4.9 million ha of land but the actual area under cultivation is only 1 million ha representing 22% of the total potential available area.

Way Forward Cont'd

2. Resource optimization

- Efficient utilization of resources- water, land, input etc to achieve optimum production.
- Precision Agriculture (PA)
- Climate-Smart Agriculture (CSA)
- Artificial Intelligence (AI)
- Internet of Things (IoT)



Way Forward

3. Categorization of Mills based on capacities

Country Representative, Nigeria and Regional Coordinator, Africa Rice Centre, Dr. Francis Nwilene

- Milling capacity should and must be categorized divided into three categories:
  - -small milling of 5.0 to 20.0 metric tonnes per day;
  - -medium capacity of 30 to 80 tonnes per day
  - -high capacity of 100 and above tonnes per day.
- high cost of power to run farms and mills as a major challenge

"are high cost of labour, high cost of inputs (fertilizer, certified seeds), high cost of land preparation using machines such as power tillers and high cost of mechanical harvesting using rice threshers." -Dr. Francis Nwilene

...Way Forward cont'd

4. Creating Rice Research Institutes

Handle all researches related to rice from breeding processing to post-harvest operations in Nigeria. Pulling it out of the National Cereal Research Institute (NCRI) will tremendously assist in improving information that will be available to consumers for increased productivity.

Department of Agriculture

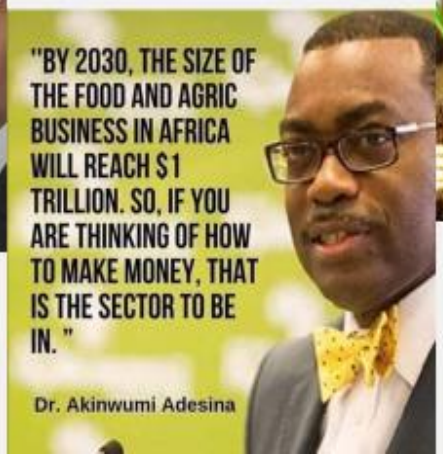
PHILRICE

PHILIPPINE RICE RESEARCH INSTITUTE

IRRI International Rice Research Institute

…Way Forward cont'd

5. Making Agriculture a Business – Agri-business



Paradigm shift from being a way of life to business

…Way Forward cont'd

6. Maximizing treated wastewater for agricultural reuse

If the UWW are treated and recycled for irrigation purposes, considerable tons of food crops could be produced and hundreds of more hectares of land cultivated.

Recycling TWW will reduce the pressure on fresh water supplies

Wastewater effluent reuse foc designing wastewater treatment

Israel as an example

- about 75% of the effluent produced in the co used for irrigation purposes
- about 20% of the total yearly use of water in the country
- 50% of the water used yearly for agricultural purposes.
- more than 60 years of effluent use for agricultural purposes in Israel.

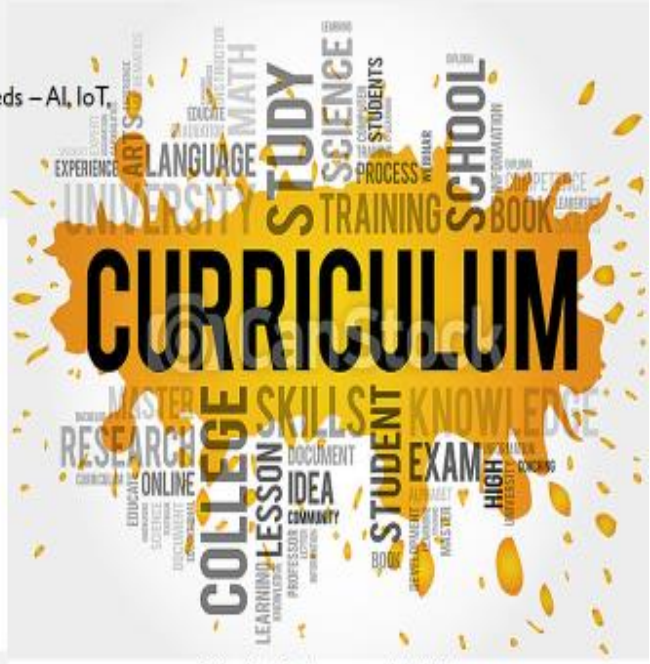
Development procedures, standards, guidelines, regulations practices and supervision to protect health and environment from negative impacts

...Way Forward cont'd

7. Agriculture's curricula review

To reflect current realities of emerging agricultural needs – AI, IoT, Agricultural Insurance,

Need driven agricultural productivity



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…Way Forward cont'd

8. 'Glocalization' – domesticating technology transfer

Importing technologies from successful countries and localizing it to suit our climate, soil type etc

Conclusion

To become food secure and self-sufficient in Nigeria:

Oil

to

Agriculture

Appreciation:

The Nigerian Institution of Agricultural Engineers (NIAE)

Pan African Society for Agricultural Engineering (PASAE)

The Federal University of Technology Akure (FUTA)

Presenter:

Engr. Professor Christopher Oluwakunmi Akinbile
Department of Agricultural Engineering
Federal University of Technology Akure
Nigeria
coakinbile@futa.edu.ng
https://scholar.google.com/citations?user=pg-k6WwAAAAJ&hl=en
https://www.scopus.com/authid/detail.uri?authorId=35766152600
https://www.researchgate.net/profile/Christopher-Akinbile

The Wealth of Waste: From Water to Rice, which can be found on FUTA repository page at: http://196.220.128.81:8080/xmlui/handle/123456789/4647

Waste to Wealth Concept: Agricultural Engineering Perspective

Waste to Wealth Concept: Agricultural Engineering Perspective

by

Engr. Prof. M. S. Abubakar, MNIAE, MNSE

A Monthly Webinar Seminar/Workshop Series Organised by the Nigerian Institution of Agricultural Engineers (NIAE) in conjunction with the International Commission of Agricultural and Biosystems Engineering (CIGR)

Department of Agricultural and Environmental Engineering
Bayero University Kano, Nigeria

On Thursday, 29th September 2022

Outline

1.0 Introduction
- Definition of Agricultural Waste (AW)
- Sources of AW

2.0 The 5Rs Concept of Waste Management

3.0 Waste to Wealth Concept

4.0 Challenges of Wealth Creation from AW

5.0 Roles of an Agricultural Engineer in Waste to Wealth Concept

6.0 Conclusion

2

1.0 Introduction

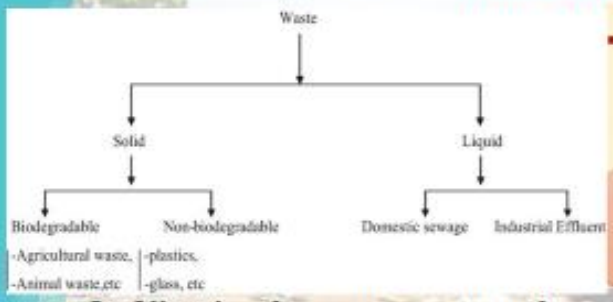
Waste

- Viewed as unwanted or unused material that has been disposed off or discarded after primary use
- Waste generation rate in Nigeria is estimated at 0.65-0.95 kg/capita/day which gives an average of **42 million metric tonnes of wastes generated annually**.
- This is more than half of **62 million metric tonnes** of waste generated in sub-Saharan Africa annually (Noiki, 2021)

3

Intro....

- **Waste generation** - food wastes, extraction of raw materials, disposable goods, processing of raw materials, consumption of final products, used electronics, other human activities
- **Waste classifications** **(based on composition and source of generation)**



In Nigeria, there are no enough sewers or underground drainage system and as a result all liquid wastes find their way into water courses

7

Intro....

- Increase in agricultural activities has naturally resulted in increased quantities of livestock waste, agricultural crop residues, and agro-industrial by-products
- So, there is likelihood to have a significant increase in agricultural waste globally if developing countries continue to intensify farming systems

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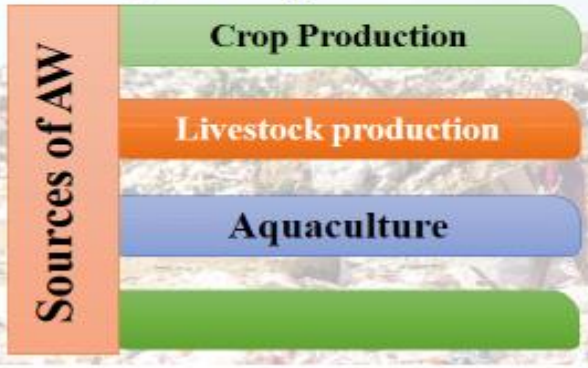
Definition of Agricultural Waste (AW)

- **Agricultural wastes (AWs)**

Residues from the growing and processing of raw agricultural products (plants and animals) such as fruits, vegetables, meat, poultry, dairy products, and crops



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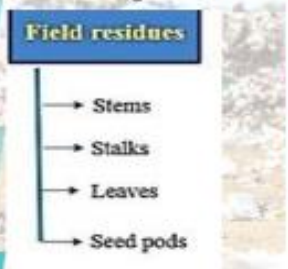
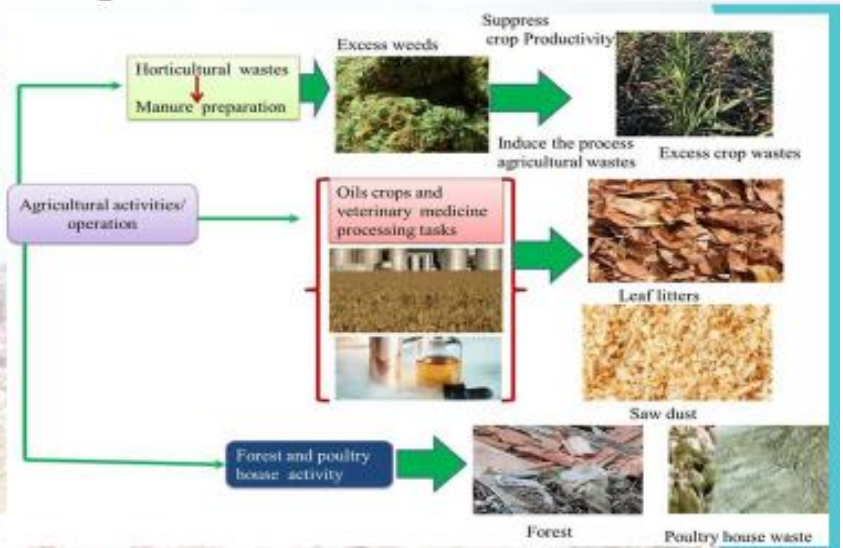
➢ AW from Crop Production

- AW from crop production activities include:

- Plant leaves, roots, stalks, unused seeds, and unripe fruits





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➢ AW from Livestock Production

- AW from livestock production activities include:

  - manure and organic materials in the slaughterhouse, animal carcasses, dead animals, hoofs, bones, feathers, bedding/liter, damaged feeders, water trough, etc

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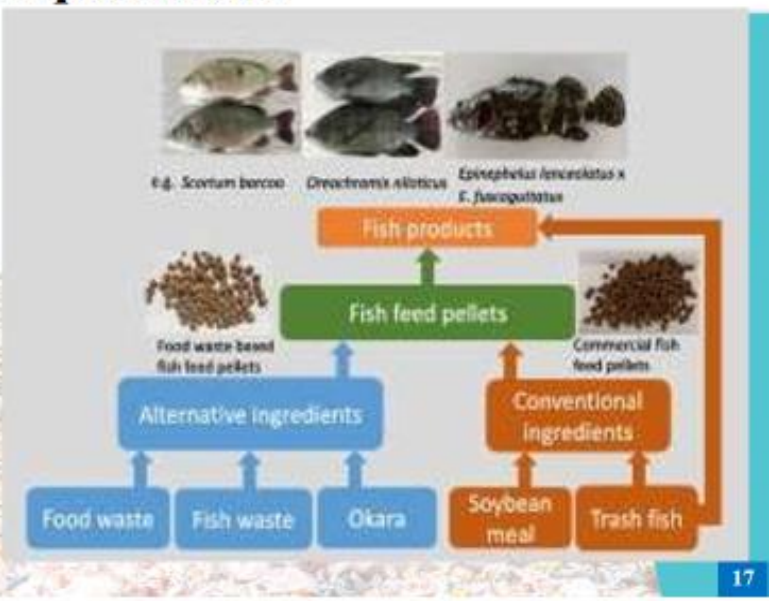
➢ AW from Aquaculture

- AW from aquaculture include:

  - waste generated from the excess feed

  - fecal droppings of cultured fish



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AW from Agricultural Produce Processing

- AW from agricultural produce processing activities include: threshing, de-husking, decortication, parboiling, milling, extraction, slaughtering, washing, etc.
- Examples of wastes generated are; Husks, shells, coats, slurry, fats, hoofs, bones, feathers, banana and cassava peels, corn stalks, sugarcane bagasse, drops and culls from fruits and vegetables, etc

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Some Facts about AW

- The global estimate of AW produced is approximately **998 million metric tonnes (MT) annually**
- **Globally, 140 billion MT of biomass is generated every year from agriculture**
- Nigeria generates an estimated **32 million MT** of solid waste annually, out of the total waste of **42 million tonnes generated in a year**
- In Nigeria, waste is generated at the rate of 0.43 kg/head per day
- **80% of agricultural waste is organic and thus has the potential to reuse/recycle**
- Nigeria generates
- **4.34 million MT of rice straw**
- **0.9 million MT of risk husk**

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Some Facts about AW…..

- Nigeria has around 19.5 million cows which generate huge amount of waste
- Calorific value of 1000 kg of cow dung will approximately generate 8000 kJ of energy
- Therefore, Anaerobically, the same 1000 kg of cow dung will produce 450 cubic meter of biogas
- And if used as bio-fuel will produce 1260 kW/h
- BUA Foods Ltd generate 105,000 MT of bran annually

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2.0 The 5Rs Concept of Waste Management

REDUCE

REUSE

RECYCLE

RECOVER

REPAIR

•**REDUCE**

-to lessen the amount of waste produced.

This can be done by using less materials that are readily disposable either biodegradable or nonbiodegradable.

•**REDUCE**

✓Buy rechargeable batteries instead of disposable batteries.

✓Buy products in bigger packs than those in small sachets.

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The 5Rs Concept of Waste Management...

•REUSE

-to use the material for the same or another purpose.

•REUSE

- ✓Use ecobags shopping or going to the grocery store
- ✓Donate clothes and other useful materials to some organizations that conduct relief operations during calamities.
- ✓Making use of empty glass jars as sugar or coffee container.

•RECYCLE

-to create or turn used materials into a new product.

•RECYCLE

- ✓Empty plastic bottles into pencil/crayon case
- ✓t-shirt that turns into grocery shopping bags
- ✓Used tires as **plant pot**

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The 5Rs Concept of Waste Management...

•RECOVER

- taking energy or materials from wastes that cannot be Used anymore.

•RECOVER

- ✓Plastic to gasoline
- ✓Plastic-to-oil technology

-it involves heating wastes in the presence of water and processing them to produce crude oil

- ✓Incineration Technology

•REPAIR

- fixing broken things or old materials so that it can be used again.

•REPAIR

Repairable materials include furniture, appliances, and clothes.

If still repairable, these should be repaired instead of buying new materials to replace them.

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Why Waste Management?

Saves one's money because you can hardly buy new products when you recycle, reuse, and repair them.

Recovering used materials enables us to benefit from using free electricity and fire for cooking our meals.

Free from pollution and wastes.

Keeps resources from running out.

Wealth Creation

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3.0 Waste to Wealth Concept

- The Waste to Wealth Concept simply means transforming waste into a useful material that could further be sold to generate money (wealth)
- Innovative waste conversion processes can create micro-entrepreneurship opportunities on small-medium scales
- Waste is only in the eye of the beholder that imagines waste, but to agricultural engineers waste can be transformed into useful material and this can further help in generating wealth.
- Therefore, the perception of "waste" should not hold, as every unit of output from agricultural production activities should be viewed as an opportunity to generate value (such as in integrated farming system)

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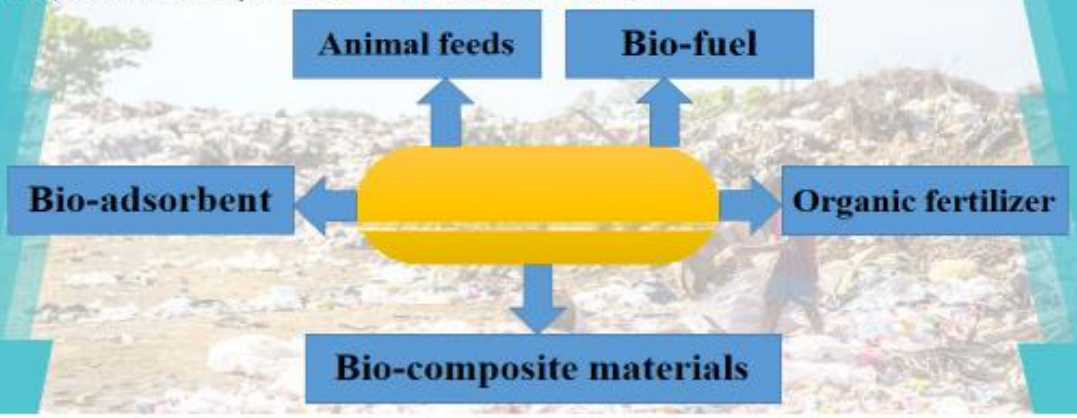
Waste to Wealth Concept…..

- **Agricultural wastes (AWs) can be converted into different forms which are beneficial in reducing environmental pollution and to create wealth, hence "Waste to Wealth"**



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Conversion of AW to Animal Feeds

- AW generated from processing operations viz. threshing, de-husking and milling can be used in feeding of various animals and for the development of various value-added products.
- Rice and wheat bran can be served directly to some animals such as goats, cattle, and even pigs.
- Corn bran, groundnut cake, and sesame cake can be integrated with other elements and served to poultry birds as feeds.
- Dead birds can be served to catfish as a good source of food.

A conversion process of agricultural waste into an animal feeds

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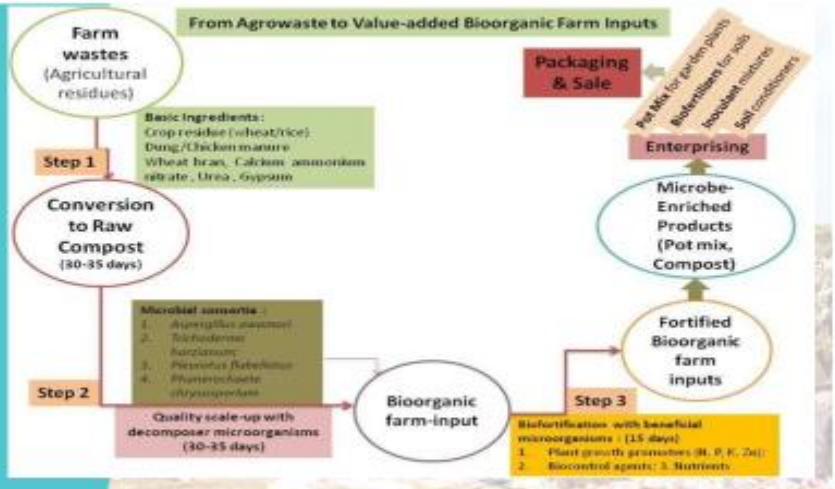
Conversion of AW to Organic Manure/Fertilizer

- AW can be converted into organic manure, which is more environmentally friendly than inorganic fertilizer
- Organic manure boosts crop production, lower the cost of production and as well offers various health benefits than inorganic fertilizer
- The use of organic manure is good but the application of raw animal waste on farm land could lead to land pollution
- However, some animal wastes are acidic in nature and can lead to the death of crops. So the best advice is to let waste decompose first
- Decomposition helps to breakdown the acidic content of the waste and makes it less harmful to the soil and the plants which it is meant to nourish

A conversion process of animal waste into an organic manure

20

Conversion of AW to Organic Manure/Fertilizer…….



A conversion process of agricultural waste into an organic fertilizer

21

Conversion of AW to Bio-fuel

- Bio-degradable AW can be converted to Bio-fuel
- There are 2 major categories of Bio-fuel, namely; Solid & Liquid Bio-fuel
  - Solid Bio-fuel: This has resulted from the densification of biomass into pellets and briquettes
- Pellets and briquettes stand as replacements for coal and firewood

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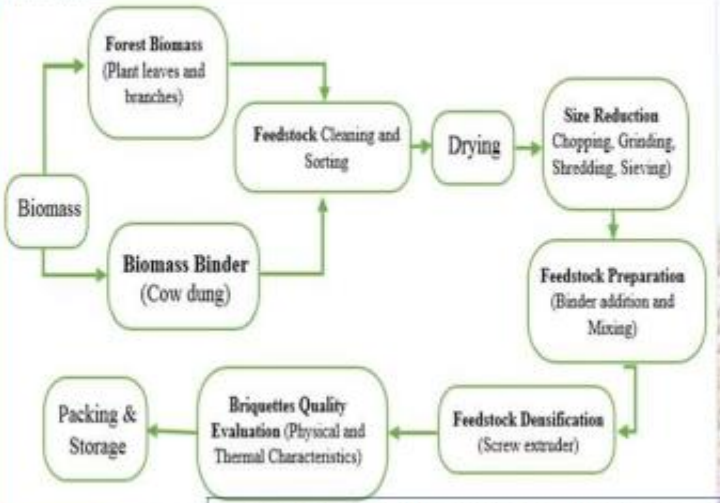
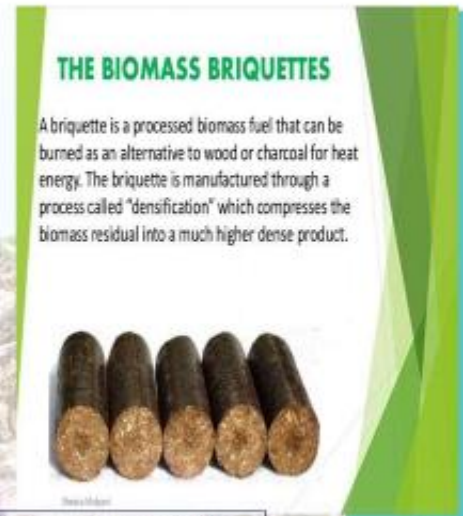
Conversion of AW to Bio-fuel….



A conversion process of agricultural waste into a solid bio-fuel



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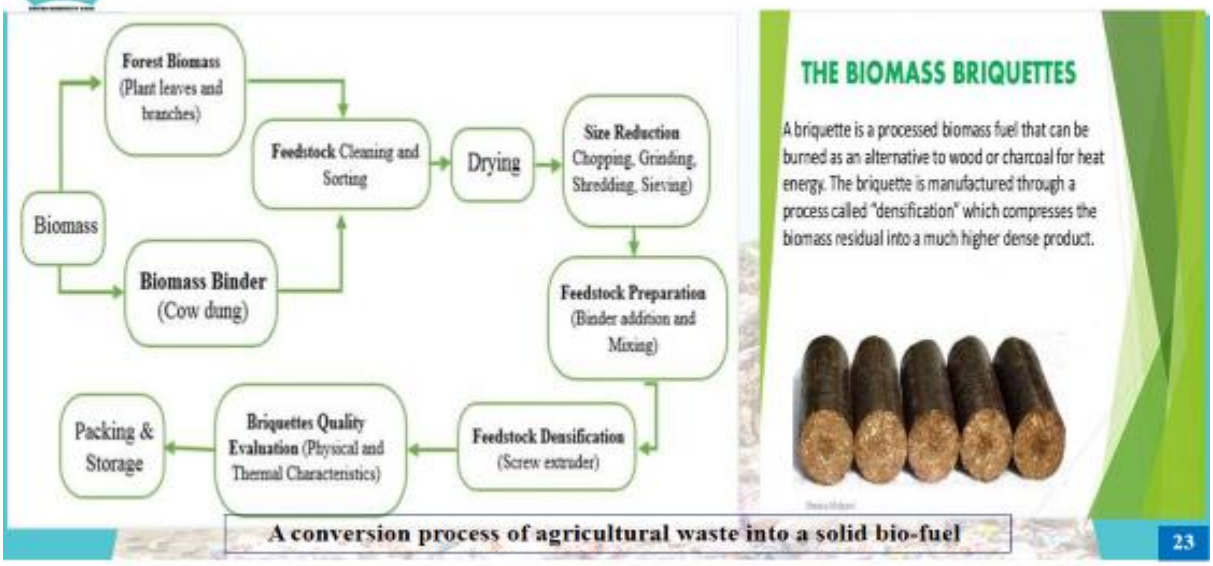
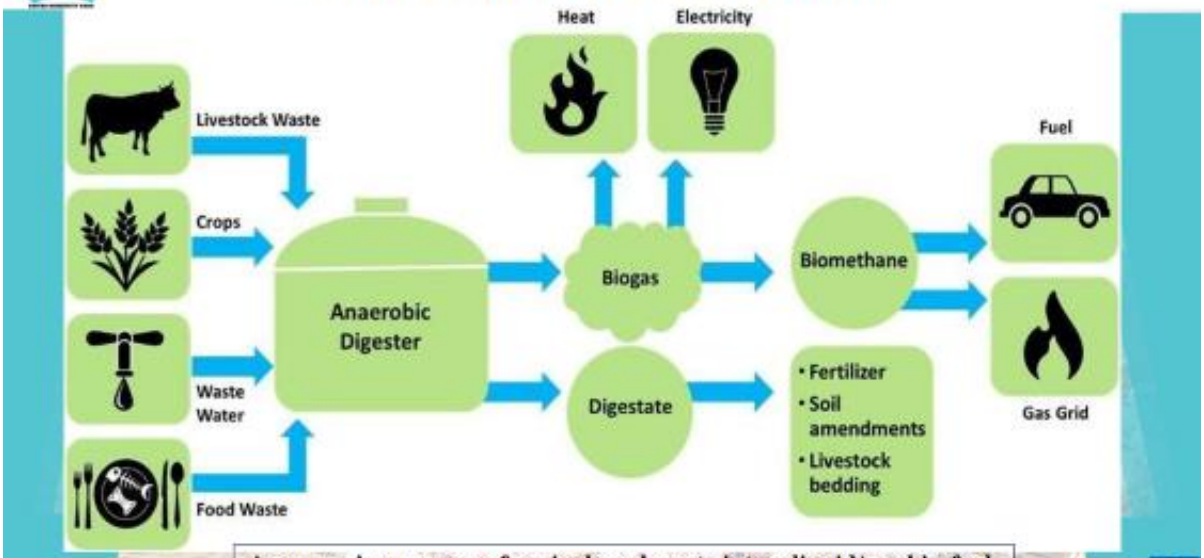
Conversion of AW to Bio-fuel….



A conversion process of agricultural waste into a solid bio-fuel

23

Conversion of AW to Bio-fuel….

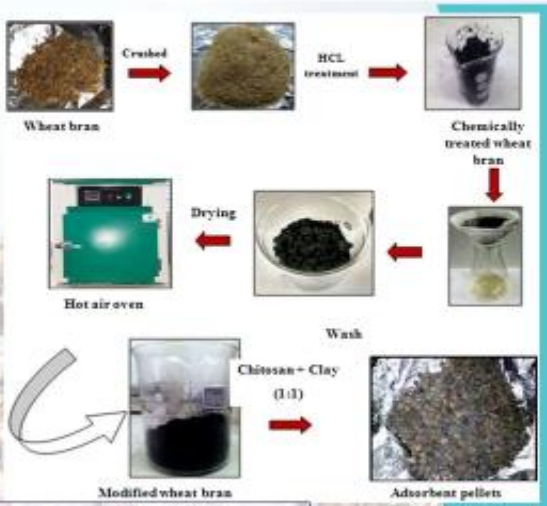


A conversion process of agricultural waste into a liquid/gas bio-fuel

25

Conversion of AW to Bio-adsorbent

- An *adsorbent* is a solid substance used to remove contaminants from liquid or gas that can harm the environment
- Recently, AWs have proven to be a low-cost alternative for the treatment of effluents containing heavy metals through the adsorption process
- The low-cost AW such as sugarcane bagasse, rice husk, sawdust, coconut husk, oil palm shell, neem bark, etc., are used to produce Bio-adsorbent with high efficacy



A conversion process of agricultural waste into a bio-adsorbent

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Conversion of AW to Bio-composite Materials

- A bio-composite is a material composed of two or more distinct constituent materials (one being naturally derived) are combined to yield a new material with improved performance over individual constituent materials
- Aws being derived naturally are used to produce Bio-composite materials

A conversion process of agricultural waste into a bio-composite material

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4.0 Challenges of Wealth Creation from AW

The following are some of the challenges of wealth creation from AW;

- Lack of technical know-how in handling diverse AWs
- Lack of required infrastructure/facilities (collection, storage, pretreatment, utilization, etc such as digester)
- Inconsistency in the pattern of agricultural production
- Constant availability and supply of the Aws
- Lack of Public-Private-Partnership (PPP)
- Lack of supportive government policies on subsidy for farmers to encourage for adopting the process of agro-waste to wealth

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5.0 Roles of an Agricultural Engineer in Waste to Wealth Concept

- **Agricultural Engineers** have an important role to play in transforming waste to wealth, such as:
- Development of structures to store waste from agricultural and non-agricultural activities
- Development of processes to transform the waste product into useful material that can generate wealth
- Development of systems that help to minimize waste production
- Agricultural engineers attempt to solve agricultural problems concerning power supplies, the efficiency of machinery, the use of structures and facilities, pollution and environmental issues in addition to storage and processing of agricultural products

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6.0 Conclusion

- Agricultural waste is a valuable resource that can be converted into a variety of useful products to create wealth
- Creation of wealth from AW is a beneficial tool to reduce environmental pollution, to promote food security, to increase fiscal growth and improve crop cultivation
- To generate more wealth from AW, establishment of small scale industries involved in transforming waste to useful products should be developed in rural and remote areas

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Thank You for Your Kind Attention

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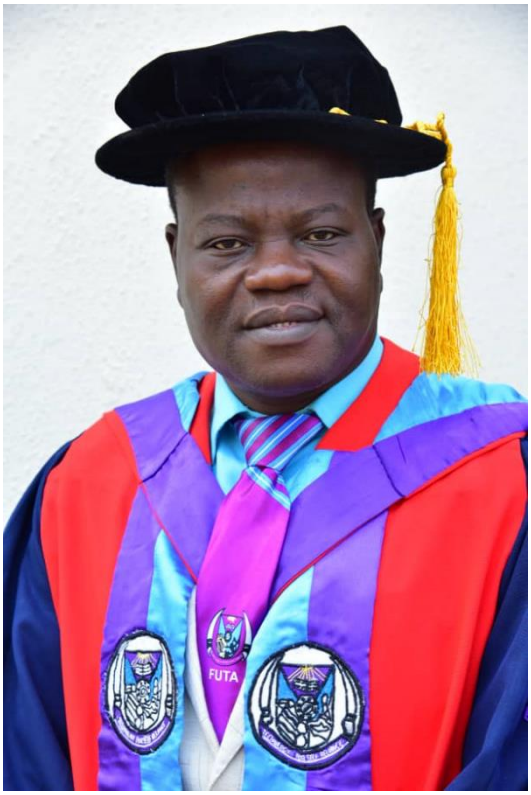
Applications of Emerging Technologies in Agriculture - Selected Case Studies from Nigeria

Applications of Emerging Technologies In Agriculture - Selected Case Studies from Nigeria

Prof. Philip G. Oguntunde (PhD)

Department of Agricultural & Environmental Engineering
The Federal University of Technology, Akure, Nigeria



OUTLINE

- ❑ Introduction
- ❑ Case Study I: Drought Forecasting
- ❑ Case Study II: Climate -Yield Modelling (Rice)
- ❑ Case Study III: Computation of Cocoa water use / characteristics
- ❑ Concluding Remarks

INTRODUCTION

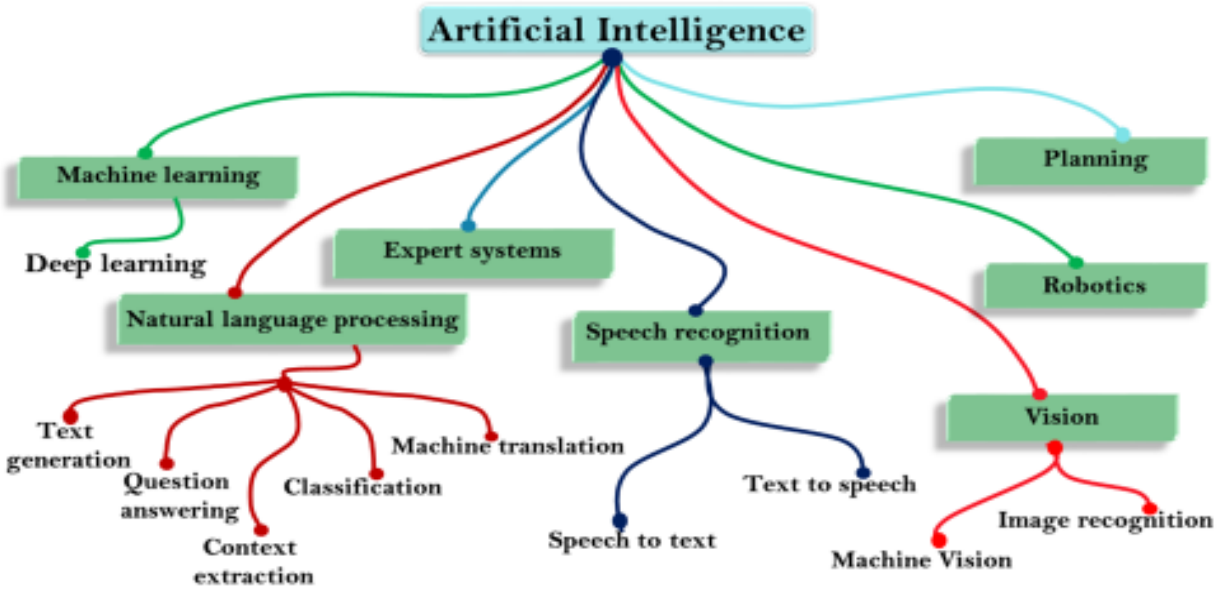
- ✓ Agriculture and water resources development are crucial to the economic and social well-being of every country.
- ✓ Advances in technology is increasing on daily basis
- ✓ Technologies are very essential to accomplish specific tasks, especially in the field of agriculture.
- ✓ Staying abreast of new technologies in the agricultural sector is a must to achieve food security.

Technological Developments In Agriculture

Technology has played a major role in the agricultural industry. Some of the areas include:

(1). Crop production (2). Weather forecasting and nowcasting (3). Harvesting (4). Storage and processing (5). Weed management (6). Crop and soil water and nutrient monitoring and (7). irrigation

Artificial Intelligence Sub-divisions



https://www.javatpoint.com/subsets-of-ai

11

Common Machine Learning Methods

- Regression
- Classification
- Clustering
- Dimensionality Reduction
- Ensemble Methods
- Neural Nets and Deep Learning
- Transfer Learning
- Reinforcement Learning
- Natural Language Processing
- Word Embeddings

13

Selected Case Studies from Nigeria

Case Study I: Drought Forecasting

- Drought has lead to an economic damages estimated at USD135 billion in the twentieth century.
- Drought is a natural disaster that is very difficult to predict due to its insipid characteristics.
- Drought indices are indicators for quantifying the severity or magnitude of drought events.
- Application of machine learning has increased the predictive capacity of drought characteristics- onset, frequency and severity.
- Artificial Neural Network (ANN) was used to predict Standardized Precipitation Evapotranspiration Index (SPEI) using

17

Methodology carried out:

19

Southern Oscillation Index (SOI) and North Atlantic Oscillation (NAO) as well as various hydro-meteorological factors (precipitation, minimum and maximum temperature, solar radiation and sunshine hours)

↓

Artificial Neural Network (ANN) embedded in MATLAB (R. 2013a)

↓

NARX network, trainbr and trainlm algorithms were adopted to train, validate and test the Models

↓

Thirty-five (35) years data was used in this study, twenty-four and half (24 ½) years for training, three and half (3 ½) years for validating while the remaining seven (7) years was used for testing the models.

↓

Statistical evaluation of model performance using RMSE, MAE, R^2 and Nash–Sutcliffe Coefficient of Efficiency (E)

RESULT

Table 1: Drought Forecasting Models

Input Model	Archi-tecture	Training Algorithm	Hidden transfer function	Output transfer function	Training			Validation		
					RMSE	R^2	MAE	RMSE	R^2	MAE
M1	9-8-1	trainlm	Tansig	Linear	0.235	0.905	0.179	0.367	0.683	0.295
M2	**9-8-1**	**trainbr**	**Tansig**	**Linear**	**0.125**	**0.972**	**0.089**	**0.145**	**0.942**	**0.109**
M3	7-8-1	trainlm	Tansig	Linear	0.223	0.905	0.165	0.446	0.680	0.353
M4	7-8-1	trainbr	Tansig	Linear	0.204	0.924	0.155	0.190	0.893	0.148
M5	2-12-1	trainlm	Tansig	Linear	0.200	0.928	0.154	0.338	0.758	0.261
M6	2-12-1	trainbr	Tansig	Linear	0.243	0.893	0.184	0.291	0.823	0.233
M7	5-8-1	trainlm	Tansig	Linear	0.250	0.888	0.191	0.401	0.621	0.298
M8	5-8-1	trainbr	Tansig	Linear	0.239	0.896	0.180	0.246	0.840	0.195

21

MODEL PERFORMANCE

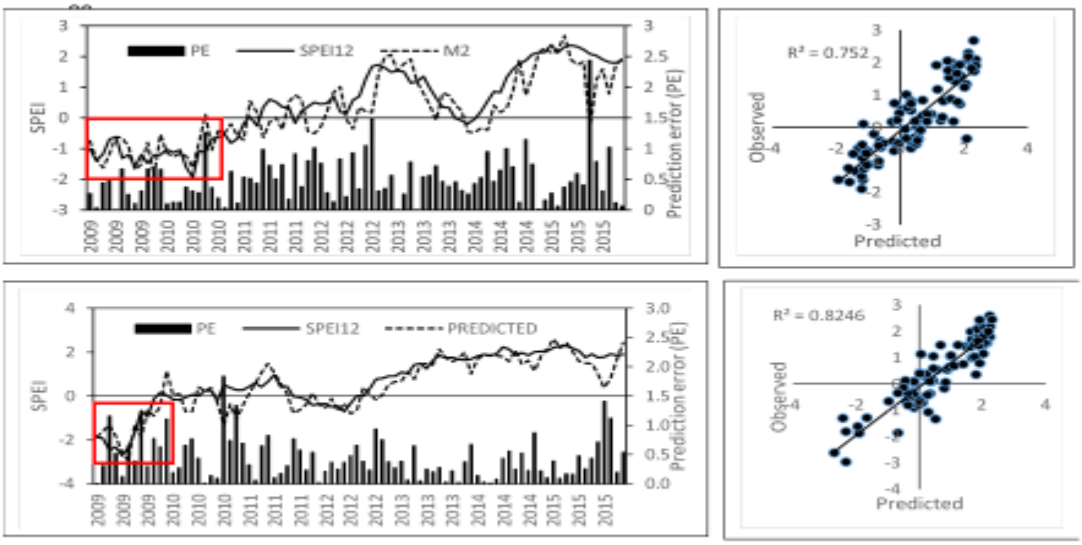


Figure 1 : The observed and the predicted SPEI plotted with the corresponding prediction error (PE) over the test period (2009–2015) (a) Nguru (b) Kaduna

Case Study II: Climate -Yield Modelling (Rice)

- Most studies on rice production have been focused on variety improvement and on soil management to boosting yield.
- There is the need to complement these efforts with studies that are capable of teasing out information on climatic conditions that may lead to better yield in different cultivars.
- Analysis of historical data to unveil long and short term couplings between yield and climate variables may provide such information.
- Therefore advanced tools of modern machine learning techniques can be used to explore cause-effect relationships with substantial non-linearities.

METHODS

- **Data**: Monthly pan evaporation (E), rainfall (R), solar radiation (S), wind speed (W), temperature (T) and relative humidity (H) data were obtained from the database of the International Institute of Tropical Agriculture (IITA) Ibadan. Annual rice yield from the Africa Rice Centre in IITA Ibadan. The data spanned for 36 years, from 1980 – 2015.
- **Principal component analysis (PCA)** was used to further reduce the long list of climatic (predictor) variables to significant principal components with eigenvalues greater than 1
- **Support vector machine (SVM)** regression tool was used to model the relationship between rice yield and climate factors

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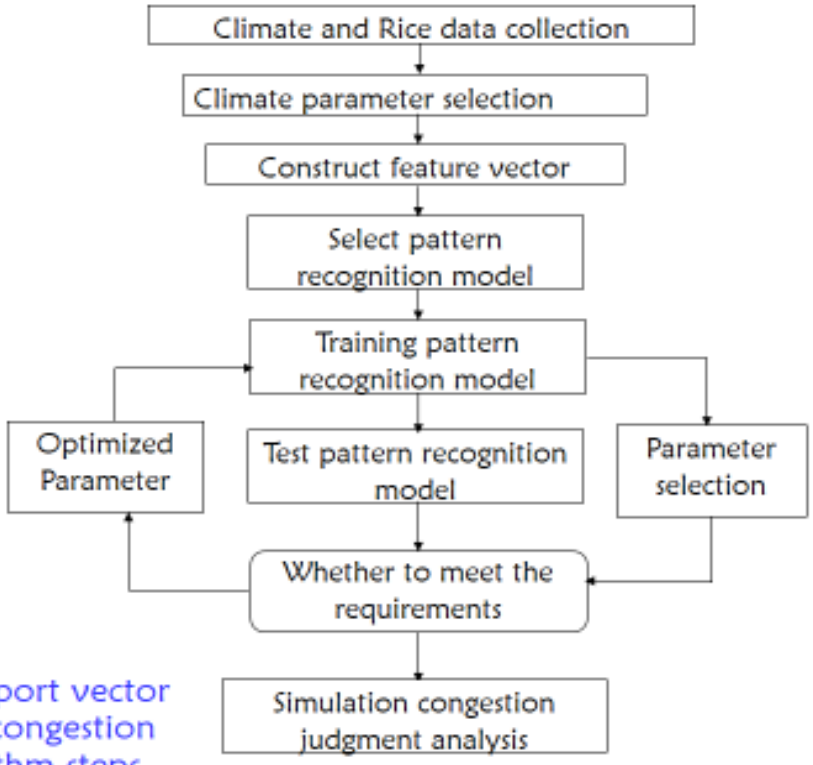

Figure 2: Support vector machine based congestion detection algorithm steps

29

RESULTS

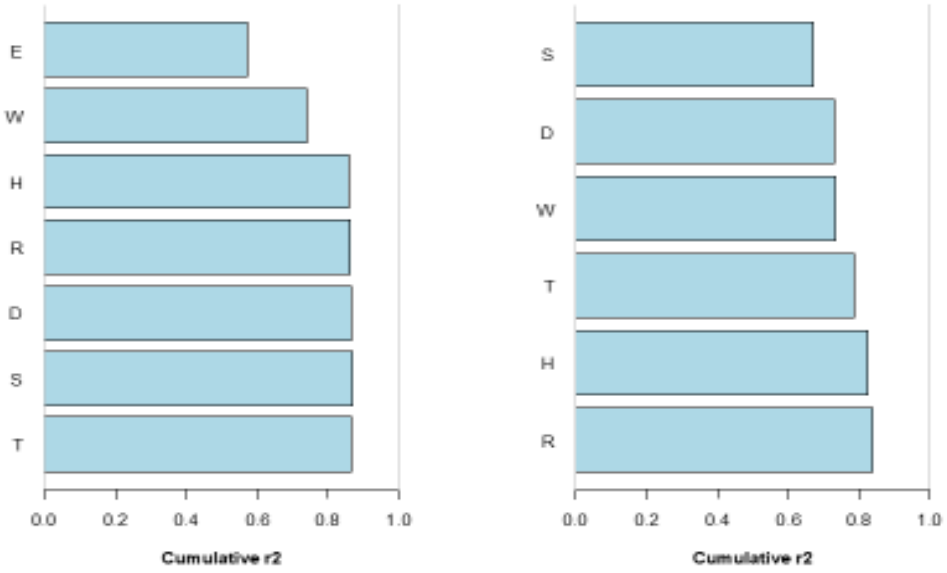

Figure 3: Performance of SVM regression with annual values, with (left panel) and without evaporation (right panel) 31

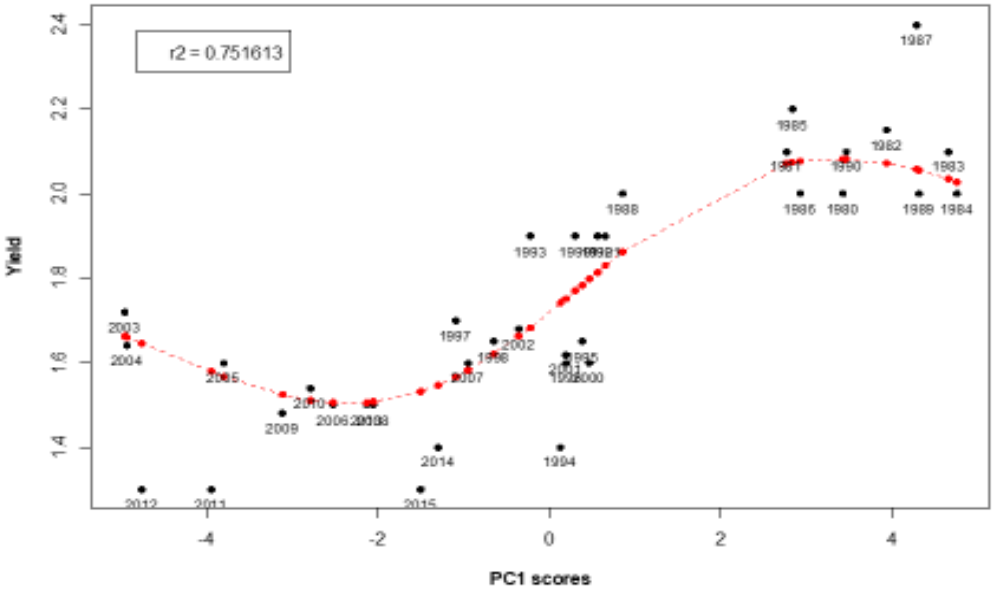

Figure 4: Rice yield versus scores of the first principal component. Black symbols are observed; red symbols are SVM regression function 33

Case Study III: Cocoa water use *App*

Background

- Water is one of the most important inputs essential for the production of crops.
- Without it, basic functions of crops such as photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients, cell division and etc would not be carried out efficiently.
- Modelling cocoa water use and its characteristics using an online web application will simplify the estimation of ETo, sap-flow density and provide a near real-time information.

35

Methodology

- Cocoa sap flow density was measured with thermal dissipation sensors and the average value of the temperature difference sampled at 10s and stored every 15 minutes with a data-logger for a period of 366 days.
- Eight weather variables were monitored similarly for the same period of 366 days.
- Design of web application system, which consist of two sub-sections namely:
  - estimation of water-use characteristics using R packages (*Rio, tidyverse and lubridate*) and
  - design of graphical user interface Using Shiny R Package

37

Running the Developed Application

Figure 5: Framework of Web Application System 39

OUTPUT

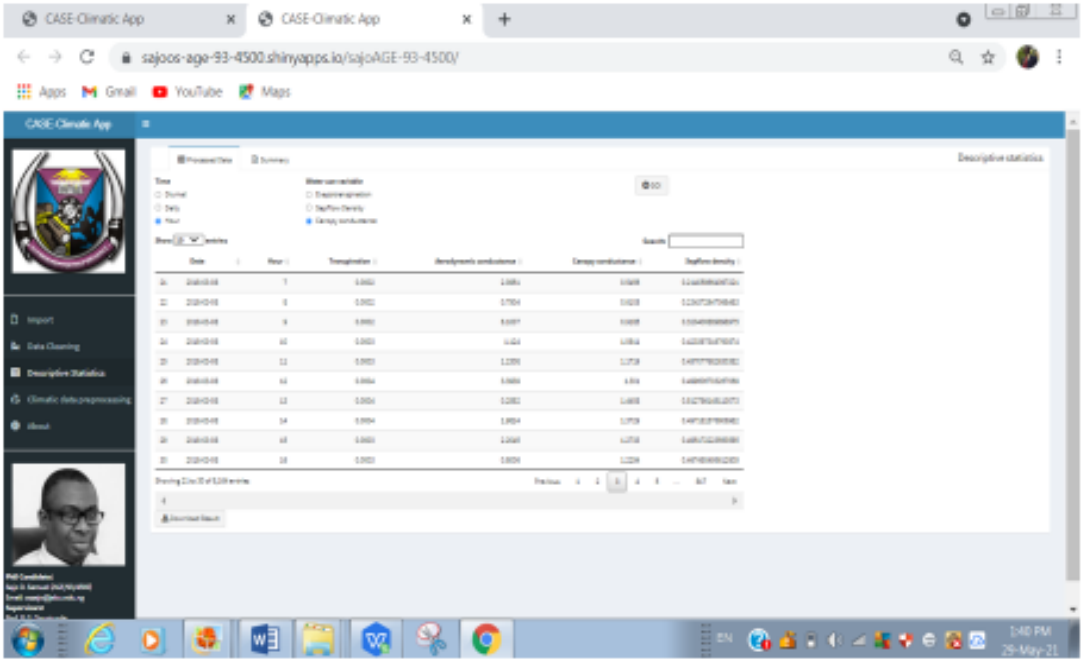

Figure 6: **Graphic display of the processed result** 41

CONCLUSION

- Solving difficult agricultural problems demand the use of emerging technologies in the areas of big data analytics, artificial intelligence (AI), remote data transfer, cloud computing, etc.
- Developing countries still have a lot to do in catching up with the rest of the world in the application of technology to achieve AGENDA 2063.
- These emerging technologies must be incorporated into the curriculum of Agricultural Engineering in order to make our training relevant in the 21st century.

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Thank You for Listening

Entrepreneurship in Agricultural and Bioresources Engineering (ABE) Practice for Wealthy Creation

Entrepreneurship in Agricultural and Bioresources Engineering (ABE) Practice for Wealthy Creation

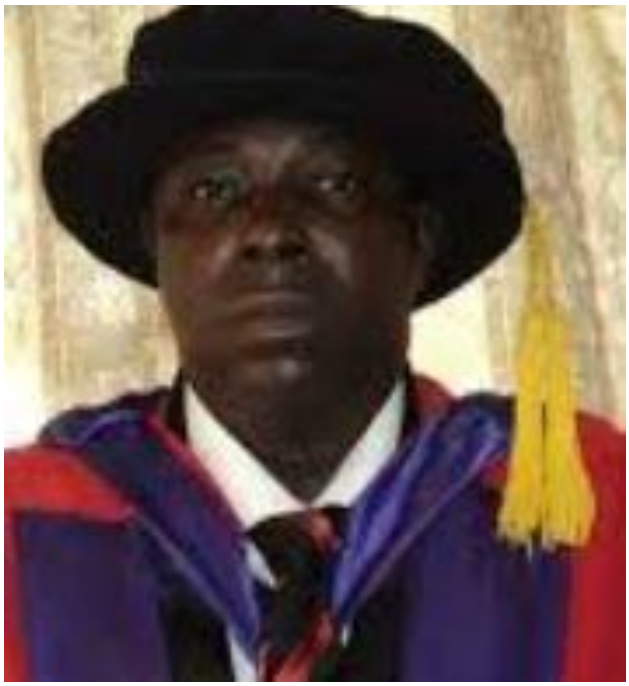
The International Commission of Agricultural and Biosystem Engineering – Nigerian Institution of Agricultural Engineer (CIGR – NIAE) Monthly Webinar

Engr. Prof. B. A. Adewumi, FAEng, FNSE, FNIAE, FAIMP.

Past Director, Centre for Entrepreneurial Studies (CENTS)

Dept of Agricultural & Bioresources Engineering

Fed. Univ. of Agric., Abeokuta (FUNAAB), Nigeria



PPRESENTATION LAYOUT

- **General Introduction**
- **Objectives of the Presentation**
- **Some Practical Options of Practice in ABE in the Nigerian Context**
- **Entrepreneurial Training, Technology & ICT Applications**
- **Loan Facilities and Entrepreneurship**
- **Conclusion**

GENERAL INTRODUCTION

- The subject matter is wide enough for a 3-day seminar but limited to an introductory 30 mins presentation – don't mind.
- This introductory presentation is to prepare us for a full course, may be next year, God willing.

General Introduction (Contd.)

- ABE is a wide discipline that serves as the melting point of the entirety of agriculture, bioresources and engineering. It applies engineering in the production of:
  - *food, i.e, crop and animal materials*
  - *forest and fibre materials*
  - *other materials such as fish, wool, milk*, etc.

- *Entrepreneurship also captures entirety of the application of management and economic/ financial primciples, and industrial perspective of production.*

General Introduction (Contd.)

- *ABE does not only enhance food production but translates products from agriculture into raw materials for many industries, removes mono-economy and enhances diversified economy.*

- *Many industries cannot exist or survive without the inputs from agriculture/ ABE.*

General Introduction (Contd.)

Nigeria especially has vase agricultural resources including land span, mountains, wildlife reserves, cattle ranches, markets, water resources and other agricultural resources, which are wasting away.

Fig. 1 shows the agricultural map of Nigeria.

Therefore, Nigeria is naturally an agrarian nation and must compulsorily give agriculture & ABE the priority they deserve for the nation to have the desired industrial growth.

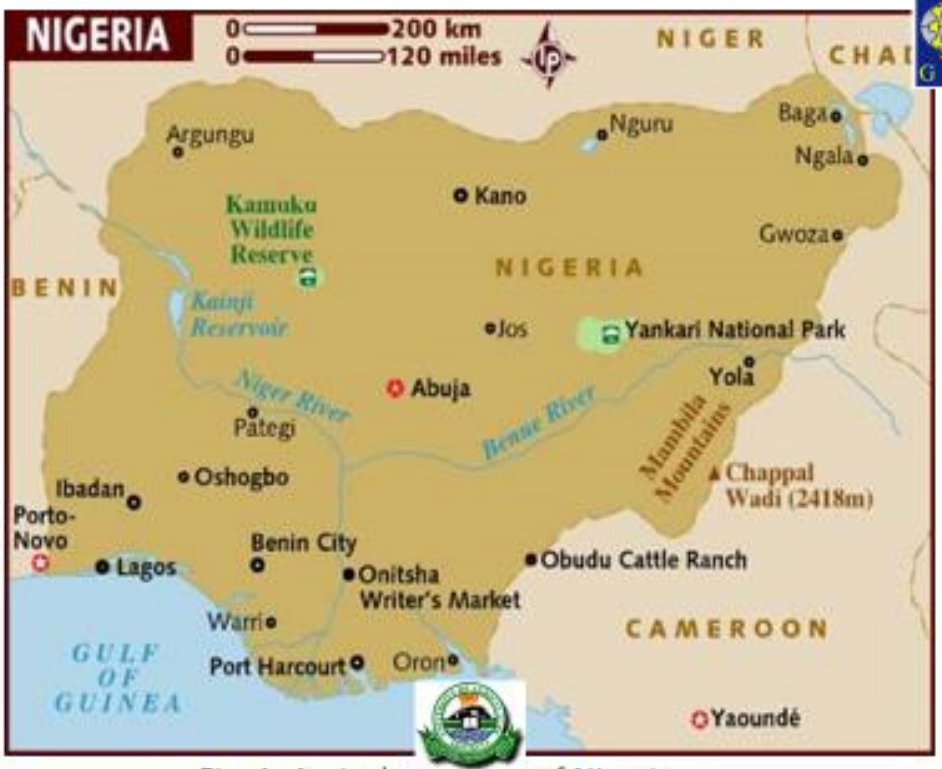


Fig. 1: Agricultural Map of Nigeria

OBJECTIVES OF PRESENTATION

Most ABE professionals in Nigeria are found in government and salary jobs with very minimal percentage involved in related private practice.

This situation is frustrating and a treat to the enrollment of students for training in ABE at tertiary education level.

This is equally worrisome and affecting many young, and even old, ABE trained professionals, wallowing in unemployment. market.

Objectives of Presentation (Contd.)

The highlight objectives of the presentation are to:

- Review various options of ABE practice available for wealth generation in Nigeria.
- Sensitize the ABE professionals in Nigeria to the possibility of generating employment through entrepreneurial practice with less reliance on salary jobs.

SOME PRACTICAL OPTIONS OF PRACTICE IN ABE

In the Nigerian context, some feasible and practical options of ABE practice include:

- Energy in Agriculture – bio diesel, solar and wind energy generation, etc.
- Waste to Wealth – Pelletized organic fertilizer, methane & briquette from agricultural waste.
- Tractor & Equipment Hiring Services - FMA.
- Mechanized Plant & Animal Farming.
- Mechanized Fisheries, Aquaculture & Domesticated Wide-life Farming.

Practical Options (Contd.)

- ABE-based Construction Services.
- Engineering Design & Patents - NOTAB.
- Consultancy Services.
- Processing of Arable and Cash Crops.
- Processing Animal Skin to Leather Materials.
- Processing Cotton to Textile Materials.
- Agro Machinery Assembly/ Manufacturing to Serve Agro-base Industries.
- Product development and added value.
- APWEN for Women Empowerment in ABE.

Practical Options

- ABE-based clusters. The innovative cluster system is a proven global concept of developing national economy
- Processing of grasses during raining season into baled hays, with legume inclusions for animal feeds

- We can always continue the list, but sufficient to mention is the fact that ABE practice shall enhance the dreamed industrialization of Nigeria.

Entrepreneurial Training, Technology & ICT Applications

- The practice of ABE is beyond theory. Hard work, availability/ involvement and records keeping are essential.

- There is a serious need for training in entrepreneurship for professionals, as identified by champion organizations such as GIZ, WADHWANI, ENACTUS that are entrepreneurial based.

- Essential content of entrepreneurial training syllabus including:

Entrepreneurial Training, Technology & ICT Applications (Contd.)

- Developing entrepreneurial mindset.
- Develop business opportunities into entrepreneurial ventures.
- Creating innovative products and services.
- Marketing strategies, including digital marketing.
- Startup, agropreneurship and lean Canvas.
- Financial plans, funding and budgeting.
- Business models and eco-system.
- Branding and patent.
- Modern technologies and ICT.
- Business upscaling and hyper-growth agribusinesses, etc.

Entrepreneurial Training, Technology & ICT Applications (Contd.)

- **The application of technology and ICT is most important in ABE practice.**
- **Therefore, the use appropriate software, machine, equipment and scientific techniques are essential.**

Loan Facilities and Entrepreneurship

- Finance is a key factor in entrepreneurship.
- While entrepreneurs are expected to raise seed money to initiate a business, it may be essential for the bank or/ and government to support to upscale and ensure conducive eco-system.

Loan Facilities and Entrepreneurship (Contd.)

- The financial institutions relevant to entrepreneur practice that provide interest at unit digit include:
  - Central Bank of Nigeria (CBN) via Agricultural Small-Medium Enterprise Scheme (AGSMES)
  - Nigerian Incentive-based Risk Sharing System for Agricultural Lending (NIRSAL) - Micro-finance bank
  - Agricultural Development Bank
  - Mortgage Bank
  - Banking & Stockbrokers Agribusiness Group (NSBAG) – Agri-insurance services

Loan Facilities and Entrepreneurship (Contd.)

- It is mostly essential to be trained and certificated by an accredited centre to be entitled for the CBN-AGSMES- NIRSAL loan.

CONCLUSIONS

- Nigeria is naturally blessed with agricultural resources and have strength for global competitiveness in agriculture which must be enhanced by ABE practice.
- Entrepreneurial principles are essential in the practice of ABE for wealth creation, with technology and ICT most important

BIBLIOGRAPHY

Adewumi, BA. 2017. Transformation of Agribusiness in Nigeria: Capital Market Inclusion and Dynamics. Invited Keynote Address Presented at the Official Launching of the Nigerian Stockbrokers Agribusiness Group (NSBAG) at IITA Lagos Guest House, WEMPCO Road, Ikeja, Lagos, Nigeria on Dec. 7, 2017.

Adewumi B. A. 2013. Strategies for transforming agricultural sector of the Nigerian economy. Proceedings of the International Engineering Conference and AGM of the Nigerian Society of Engineers, held at Abeokuta on December 9 – 14, 2013.

Adewumi B. A. 2012. Competitiveness and liberalized economy in Africa: Mirage or Reality? Key Note Address Presented at the 4th Annual Continental Conference of the Pan African Competitiveness Forum (PACF) held between Nov. 4 & 9, 2012 at Nicon Luxury Hotel, Abuja, Nigeria.

Adewumi,BA 2010. Technical Education and Enterpreneurship: Issues of Company Partnership, Curriculum and Graduate Quality. *Keynote address presented at the* 1st National Conference of the School of Engineering, Federal Polytechnic, Ilaro, *Nigeria,* held between Nov. 2 & 5, 2010.

Bibliography (Contd.)

Adewumi, B. A. 2009. Agricultural mechanization input for sustainable raw material sourcing in Nigeria. Chapter 8. In: Nagerian agro raw material development, Vol. 1: Some industrial crops and salient issues. P. O. Onwualu, S. C Obasi and , U. O. Ukpasi (Eds.). Book publication by Raw Material Research and Development Council of **Nigeria**. Pp 126 - 141.

Adewumi, B. A. 2008. Engineering education for agricultural and rural development in Africa. European Journal of Engineering Education 33(3): 321-330.

Adewumi, B. A. 2007. Indigenous technology and local content in a liberalized economy. Proceedings of Conference of the Institute of Engineers, Kenya, 10pp

Thank you for the audience

Up scaling Opportunities for Agricultural Engineers on Climate Information Services in Nigeria

Up scaling Opportunities for Agricultural Engineers on Climate Information Services in Nigeria

Nabeel Adeyemi, PhD
Consultant, Env & Climate Justice Programme,
HEDA Resource Centre, Lagos

Content

- Background
- Introduction
- Case Study – Oyo State
- Technology driven by Weather & Climate Information
- Opportunities & Strategy
- Conclusion

Background

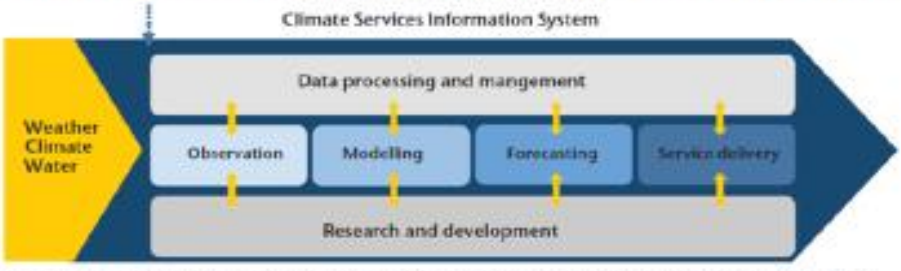
- Around 30% of global food production is affected by weather & climate vagaries (flood, drought, irregular rain)
- > 90 % of the agriculture in most countries like Nigeria is rain-fed (bi-modal season)& heavily climate-dependent
- > 85% of food production by Small-scale producers
- **NiMet** provides weather & climate information with accuracy over **85%** for the past 10 years
- Small-scale producers do not have access to **climate information** to help them respond to the threat

Introduction

Weather & Climate Information Services

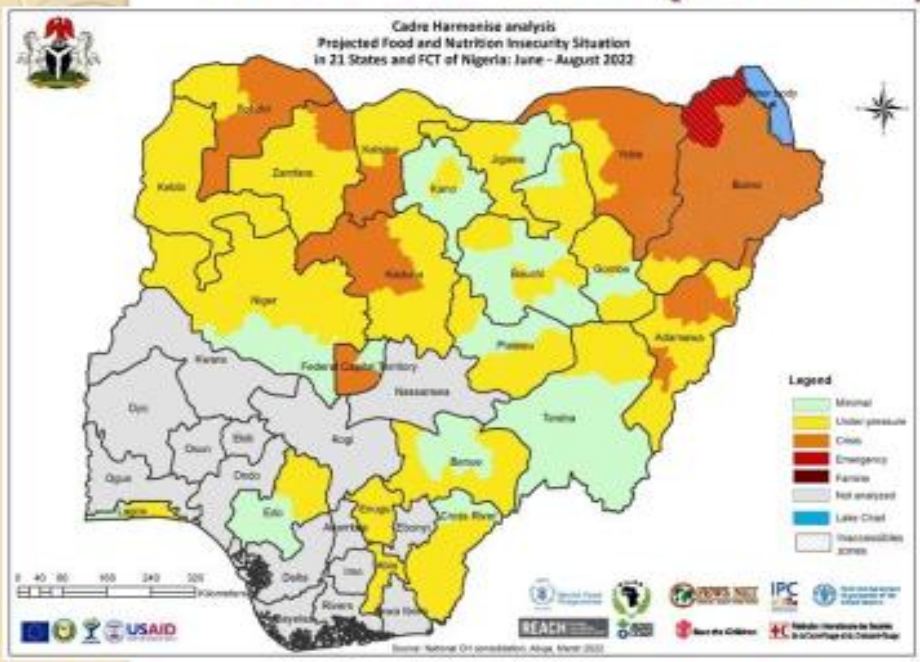
- deal with the **generation** and **provision** of weather (short range) & climate (medium & long range) information to a range of users to **support** climate-resilient development
- **inform** climate-related decision-making and climate-smart policy and planning to **reduce** the risks associated with agricultural practices

Weather/ Climate is the prime uncertain factor that dictates crop & livestock growth and development in agriculture

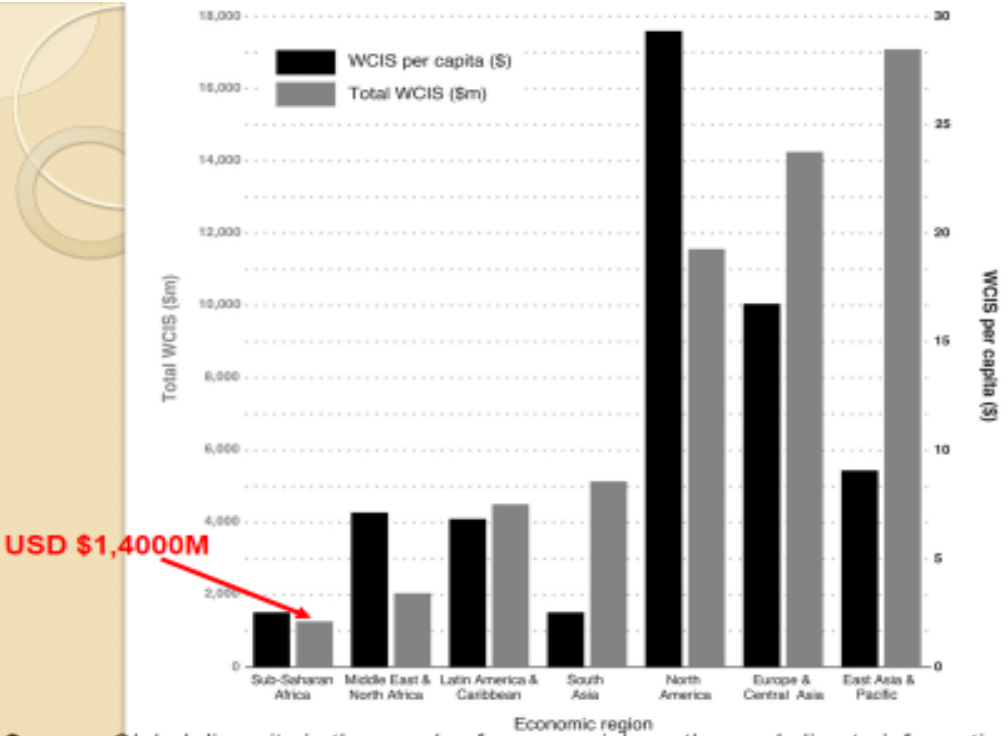


Source: Adapted from Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services (WMO-No. 1153).

Introduction (Cont'd)



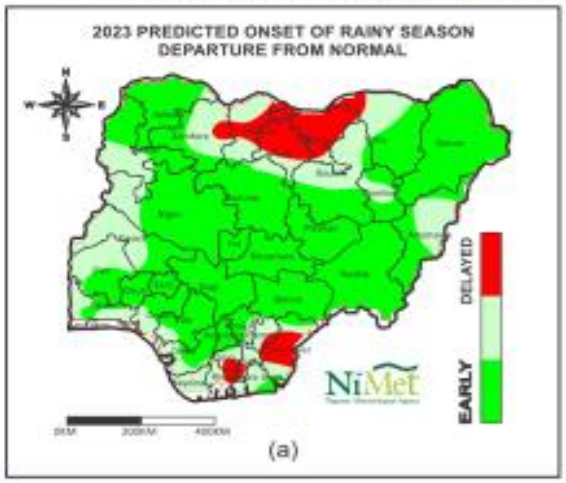
19,375,835 people are estimated to be in critical (crisis and emergency) phases of food and nutrition insecurity in the 21 states and the FCT

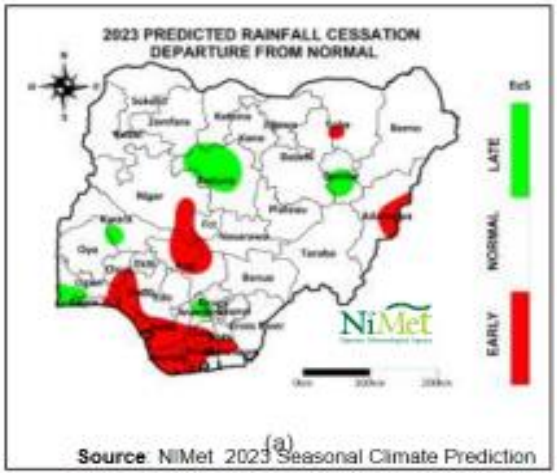


Source: *Global disparity in the supply of commercial weather and climate information services.* Lucien Georgeson, Mark Maslin and Martyn Poessinouw (May 24, 2017) Sci Adv 2017, 3:. doi: 10.1126/sciadv.1602632

Typical Weather & Climate Information

(1) Date of Onset of Rain, (2) Occurrence & Length of Dry Spells (Little Dry Season), (3) Date of Cessation of rain (4) Rain Amount (5) length of growing season (6) Day & Night temperatures (7) Soil Water Content





Source: NiMet 2023 Seasonal Climate Prediction

Weather and Climate incidences

Some Weather and Climate incidences (2012-2022)

Year	Weather & Climate related incidences	Commodities affected
2012	Heavy flooding	Reared Fish
2015	Mild drought in South West and North East	Grains and Legumes, Vegetable, Oilpalm
2018-2019	Heavy flooding, early cessation of rain	Reared Fish & Cassava producers
2020	Dry spell, Prolonged dry season, Late Onset, Early Cessation	Cassava, Maize, Millet, Soya, Oilpalm, Cocoa
2021	Dry spell, Prolonged dry season, Late Onset, Early	Cassava, Soya
2022	Dry spells, Heavy flooding, early cessation of rain	Rice, Soya, maize, Reared fish

Source: HEDA Resource Centre (Unpublished Field Survey), 2022

Impact:

Weather & Climate Incidences → Loss at Harvest → deploy old machinery & technology

Loss at Harvest: Grains, Oilpalm, Fish

deploy old machinery & technology: Manual Threshers, Manual Screw Press, -

Relevance of the AgEngineer in Value Chain Programme

A typical Agricultural Value Chain Programme

	Inputs	Production	Processing	Marketing	Consumption
Activities	Seed production (seed multiplication) (Seed Processing, grading, sorting) Seed marketing (sensitization & distribution)	Land preparation Planting Application of fertilizer and pesticides Weeding Harvesting Threshing Winnowing Drying	Bulking Transporting Loading and off-loading Milling	Sorting Quality control Packaging Transport Sales	Purchase Cooking Cleaning Transport
Actors	Seed breeder Seed companies Farmers NGOs Government	Individual farmers Farmer groups	Village assembliers Producer organizations Brokers Millers	Traders Wholesalers Transporters Retailers	Individuals NGOs Government institutions

Service Providers (Technology – Agricultural Engineer)

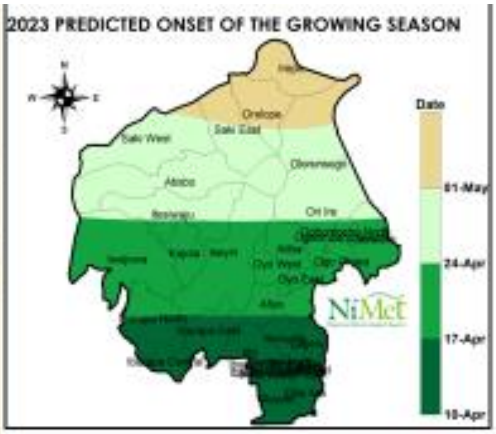
Relevance of the AgEngineer in Value Chain Programme

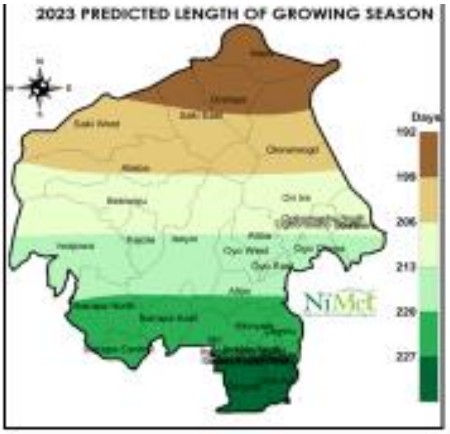
- **Agricultural Engineer**
  - ❑ leads and supports critical technology and engineering component of MOST food systems programme
  - ❑ is required for the implementation of the technology component in a typical Agricultural Value Chain programme

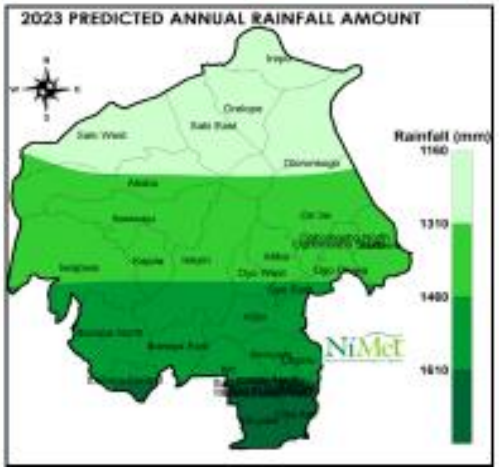
Case Study - Oyo State (2022)

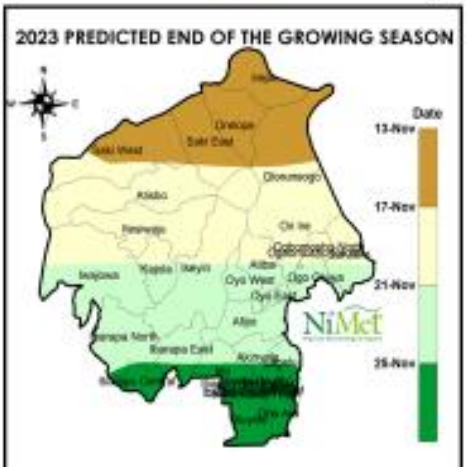
- Though not affected by the 2022 flooding, **Oyo State had extended dry spells in the northern part of the State** with impact on major crops production.
- This has been the pattern has become more frequent in the **past 5 years** and this has increased the demand for climate information services by farmers.
- The State appears not to be strong on dry season farming activities, **but most farmers relay on their minor crop** production during this time

Weather and Climate Information for 2023









Technologies driven by Climate Information

- Availability of Water during Dry Spell

Source: partner field work, 2021

Technologies driven by Climate Information (Cont'd)

- Reduce mortality during field establishment of tree crops like Cocoa & Cashew
- Applicable for Tree Crops
- Market Size **3,00,000** Ha (Tree crops)

Technologies driven by Climate Information (Cont'd)

- High-energy Passive drying tent

- Applicable for Tree Crops, Chip drying
- Market Size 1M farmers

Technologies driven by Climate Information (Cont'd)

- Soil Remediation

REBEARTH
ORGANIC WATERBASED BIO-STIMULANT

Addresses Stress in Crop production: Dry, excessive rain, cold, heat, Nutritional excesses & deficiencies, Chemical application and poisoning

Technologies driven by Climate Information (Cont'd)

- Weather Information Platform
- Market Size 38M farmers

Satyukt

Near real-time crop advisory from space at a farm level

ignitia TROPICAL WEATHER FORECASTING

weather forecasting model for tropical areas, simulating the physics that govern weather in the tropical atmosphere, with more;

Technologies driven by Climate Information (Cont'd)

Daily 48hr rainfall forecast Min. subscription for 3 months @ #1,500 for weather conditions across their farmer subscribers location and improve the advisories and technical assistance through use of our weather forecast system and tool

Strategy to Upscale Opportunities for Agric Engineers

- Institutional Collaboration on Climate Service Data & Modeling
- Promote climate-smart **Infrastructure as a Service (IaaS)** in the agricultural sector
  - Terrestrial and Marine Data Collation (Nigeria requires over 4,000 Ground Weather Stations & Buoys for Marine Data)
  - *Ground truthing* of 'climatic hotspot' for Agro-meteorology
  - infrastructure for water supply, storage & preservation, farm structures.
- Develop and support the agricultural sector with location-specific climate index for crops and livestock
- Prioritize effective and efficient communication channels that focuses on '*last mile*' challenge

Conclusion

- Weather & Climate information Service is at its nascent stage in Nigeria and the **Agricultural Engineer** has a natural advantage to scale the opportunities
- 'early warning, early action' advisory MUST be a service included in the Agricultural Engineers' Service Portfolio

Intelligent Packaging: A Precursor to Food security in Nigeria

Intelligent Packaging: A Precursor to Food security in Nigeria

Prof. Bolanle Adenike Adejumo

Food Security

- **Food is the most basic of all human survival needs**

- **"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life"**

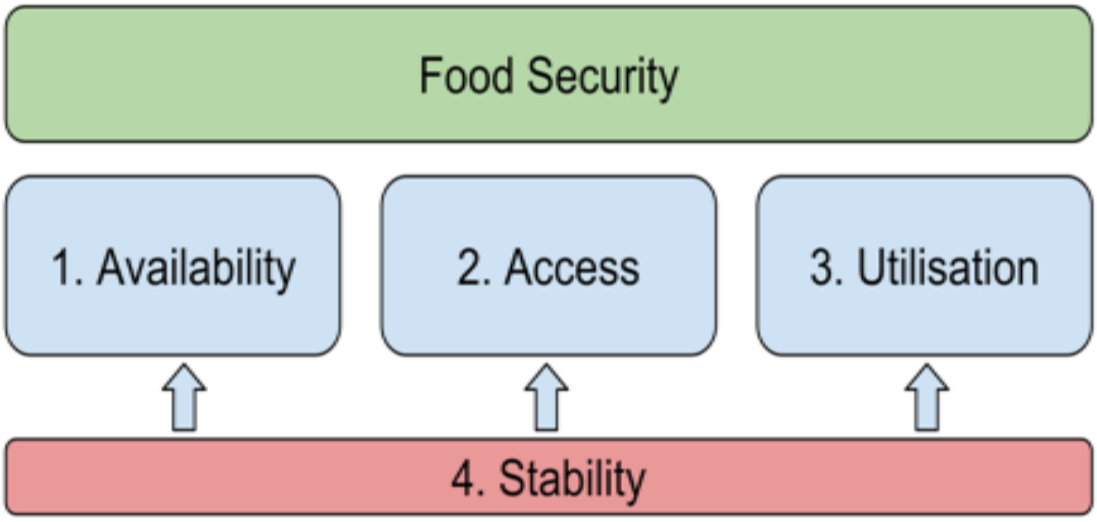


FIGURE1: DIMENSION OF FOOD SECURITY

There are four dimensions of food security

- **Food availability: availability can be affected by:**
  - **Production**
  - **Distribution**
  - **Exchange**
- **Food access: access can be affected by:**
  - **Affordability**
  - **Allocation**
  - **Preference**
- **Food utilisation: utilisation can be affected**
  - **Nutritional value**
  - **Health status**
  - **Food safety**
  - **Preparation and consumption**
- **Stability**

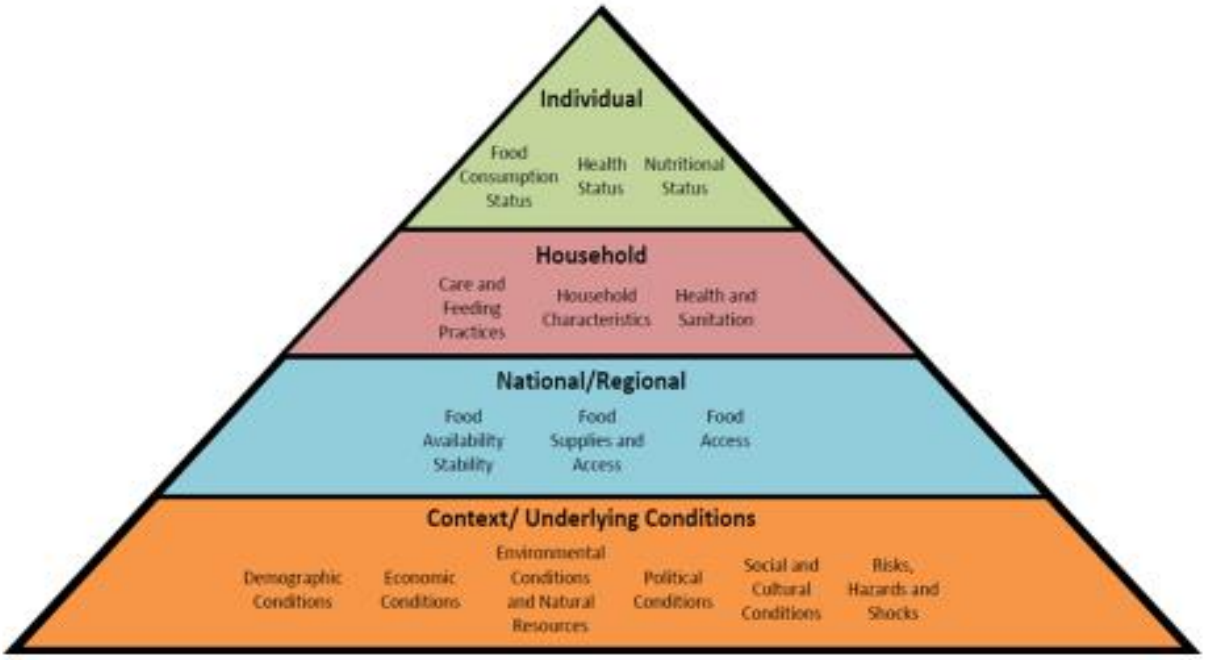


FIGURE 2: LEVELS OF FOOD SECURITY

- **The state of food security varies over a range of scales ranging from the individual to global**

- **Even where food security is present at a particular individual or household level it may not be so on a regional level.**

- **A nation or region may be generally considered to be secure, certain individual may still suffer from food insecurity**

Food Security Challenges

- **Food security in its totality is a challenge not only for the developing nations but also for the developed world.**

- **The difference lies in the magnitude of the problem in terms of its severity and proportion of the population affected.**

- **In developed nations, the problem is alleviated by providing targeted food security interventions,**
  - **Food aid in the form of direct food relief**
  - **Food stamps**
  - **Subsidised food production.**

Common Causes of Food Security Challenges

- **Population growth: it has been reported that an inverse relationship exist between the population and resources; a rapidly growing population become a burden on resources.**

- **Conflict and political instability: The relationship between conflict and food security affects each other as food scarcity leads to market collapse.**

- **Urbanisation: In developing countries, urban growth and the growing number of megacities indicate that more food is available to the people who live in an environment that has traditionally been supposed as inappropriate for agriculture**

Common causes of food security challenges

- **Climate change: It affects the crops, livestock, forestry, fisheries, and aquaculture. Thus, climate change indirectly affects the socio-economic conditions of people through agriculture, market effects, etc.**

- **Financialisation of food: Financialisation of food refers to the increasingly significant role played by financial markets in the agri-food sector.**

- **Lack of Knowledge on the use of Information Systems: Food production and rural development in countries which have food insecurity require suitable and up-to-date technologies which are lacking in developing countries such as Nigeria**

\

Effects of Food Insecurity

- **The global food crises has negative impart on the lives of millions of people in the most vulnerable communities, particularly in the countries where poverty, malnutrition and death from hunger are upswings day by day.**
- **The effect of food insecurity includes:**
- **Poverty and hunger**
- **Malnutrition**
- **Depression**

Possible Solution to Food Security Challenges

- **Policy Framework**

  There should be good policies to combat the food insecurity either by the government or private. The policies could be in the following areas:

- Close the yield gap
- Use fertilizer more efficiently
- Raise low water productivity
- Target food for direct consumption
- Reduce food waste

- **Fair-trade**
- The global competition, unfortunately, creates unfair trade between the underdeveloped, developing, and developed countries.
- As a result, food prices are increasing rapidly and also the poverty level.
- The countries which are more engaged in agricultural products come under the underdeveloped and developing countries to become even weaker.
- Therefore, it is necessary for development to ensure food commodities prices in the international market.

- **Information and Communication Technologies (ICT)**

- **The use of smartphones is more common in every state, and it is used in different fields to sort out the problems related to agriculture, health, education and rural livelihood projects in Asia.**

Food Security Status of Nigeria

- **Nigeria is the most populated country in Africa, with over 200 million people and the 7th in the world**

- **Annual growth rate of the population is approximately 2.7%**

- **Food demand in Nigeria has outstripped food production**

- **Over the years, Nigeria has been impacted by insecurity in the country.**

- **In some parts of the northern region, conflicts among farmers and herders have led to crises in which many Nigerians have been killed, displaced from their homes, and their farmlands destroyed.**

- **According to the National Bureau of Statistics, food inflation surged to 24.32% in January 2023 from the 23.75% recorded in December 2022, the highest in the last four years.**

- **"Acute food insecurity is mostly driven by the deterioration of security conditions and conflicts in northern states, which as of March 2022 (latest data available) have led to the displacement of about 3.17 million people and are constraining farmers' access to their lands," the report said.**

Food security status of Nigeria

- **Food access has been affected by persistent violence in the north-east states of Borno, Adamawa and Yobe (BAY) and armed banditry and kidnapping in states such as Katsina, Sokoto, Kaduna, Benue and Niger.**

- **According to the National Emergency Management Agency, widespread flooding in the 2022 rainy season damaged more than 676,000 hectares of farmlands, which diminished harvests and increased the risk of food insecurity for families across the country.**

- **Food wastage from the little harvest left also contributes to food insecurity in Nigeria**

- **30-40% of food produced in Nigeria is wasted due to:**
  - **Insufficient food processing**
  - **Poor post harvest facilities**
  - **Poor storage technologies**

- **FAO has projected that about 25.3 million people in Nigeria would face acute food insecurity between June to August 2023**

Intelligent Packaging

- **Intelligent packaging (IP) is any type of container that provides a specific functionality beyond function physical barrier between the food product and the surrounding environment.**

- **IP relies on data management systems to collect, analyse and process sensor and indicator generated data.**

- **These systems may consist of cloud-based platforms, databases or software applications for real-time monitoring and decision making.**

- IPs are packaging technologies that through internal and external indicators monitor interaction between the food, the packaging, and the environment.

- This type of packaging analyzes the system, processes information, and presents it, without generally exerting any action on the food.

- For the development of IP, the integration and the technological advancement of the sensors, nanosensors, and indicators are essential.

- There are two ways in the intelligent packaging systems:
  - Data systems (bars labels or radiofrequency identification plates) used to store or transmit data indicators of incidents
  - Biosensors in packaging that allow control of the environment and product packaging.

Types of Intelligent Packaging Systems

- **Time and Temperature Indicators**
- **Time and Temperature Indicators (TTI) have been widely used to monitor and translate consumer quality of foodstuffs due its simplicity, low cost, affordability and efficiency,**

- **A prerequisite for the effective implementation of a control system based TTI is the kinetic study and modeling of loss ratios food quality and response.**

- **Different types of TTI trade have been developed on the enzymatic base and polymeric and biological reactions.**

- **To ensure the safety and quality of food products that need a certain temperature, it is important to monitor changes in the parameters of temperature and time from production to the final consumer.**

- **TTI can be placed in transport containers or individual containers as a small sticker; an irreversible chemical change will be reflected if the food is exposed to a different recommended temperature**

- **TTI are particularly important for the quality and safety of chilled or frozen food, where cold storage is a critical control point during the transport and distribution.**

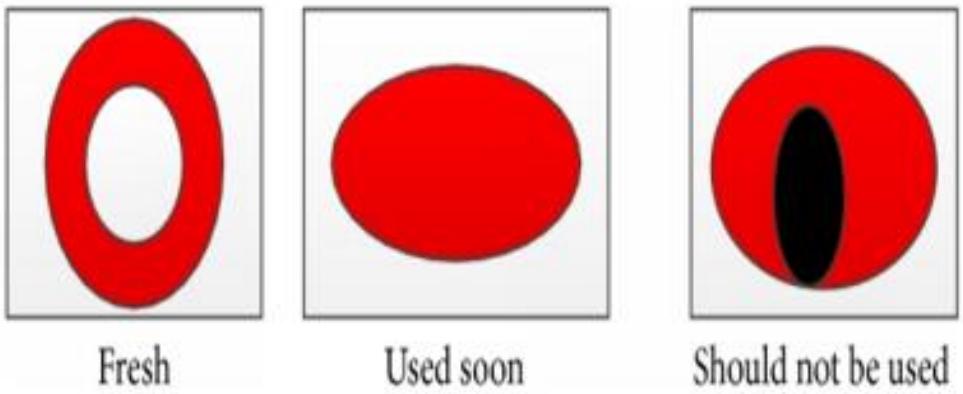


FIGURE 3: SCHEMATIC REPRESENTATION OF TTI FRESH-CHECK

FIGURE 4: SCHEMATIC REPRESENTATION OF TTI: TIME STRIP

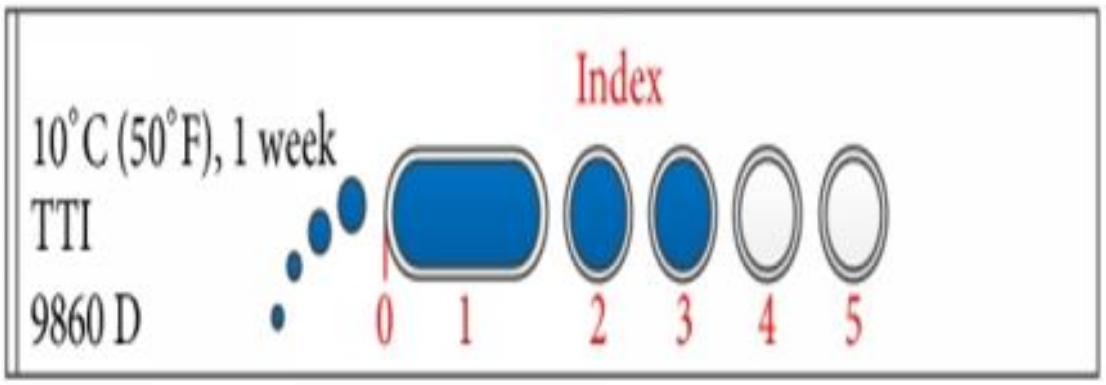


FIGURE 5: SCHEMATIC REPRESENTATION OF TTI MONITOR MARK

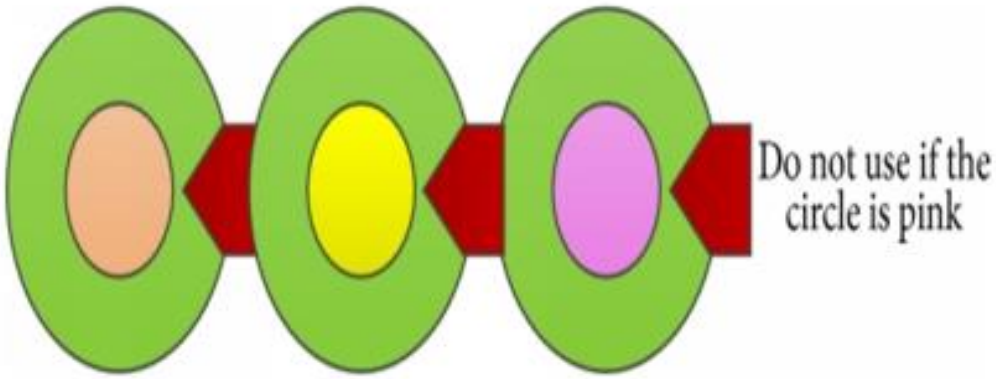


FIGURE 6: SCHEMATIC REPRESENTATION OF TTI: CHECK POINT

- **Integrity Indicators**

- **The gas composition in the package may change due to the interaction of food with the environment.**

- **Gas indicators are a useful means of controlling the toxic composition of the gases produced from decomposing food in a food container that can endanger the health of consumers; as a control measure, a change occurs in the indicator color by chemical or enzymatic reaction.**

- **The tag is activated at the time of consumption, the seal is broken when a timer goes off, and a color change is experienced over time.**

- **Indicators must be in direct contact with the gaseous environment immediately surrounding the food in a container.**

- **Plastic optical fluorescent films are highly sensitive for the detection of gases and dissolved CO_2.**

- **The detection of CO_2 in modified atmosphere (MAP) and conventional packaging have gained considerable attention in the industry IP.**

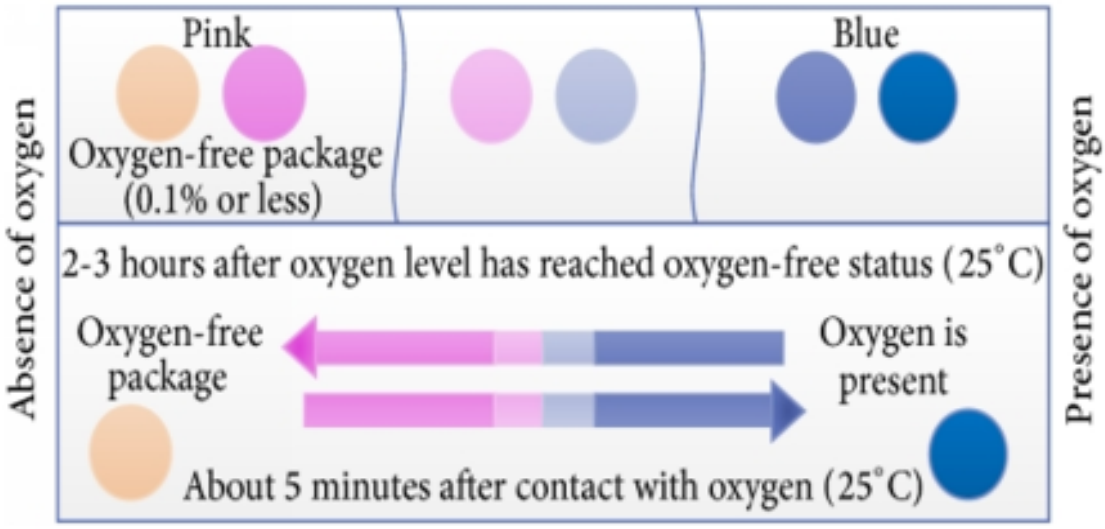


FIGURE 7: SCHEMATIC REPRESENTATION OF LEAK INDICATORS

Types of Intelligent packaging Systems

- **Freshness Indicators**

- **A freshness indicator directly indicates the quality of the product; it is usually in the form of labels on the container.**

- **Typically, these indicators focus on the detection of the first kind of change (pH, gas composition, etc.)**

- **These changes are detected by the indicators and transformed into a response, usually a color response which can be easily measured and correlated with the freshness of food.**

- **This response can be conditioned by the modifications of substances that are related to the metabolism of microorganisms, such as the occurrence of volatile nitrogen compounds, amines, organic acids, carbon dioxide, ethanol, glucose, or sulfur compounds during storage indicating microbial growth.**

- **This type of indicators is based on indirect detection of metabolites through color indicators (e.g., pH) or based on direct detection of metabolites by biosensors.**

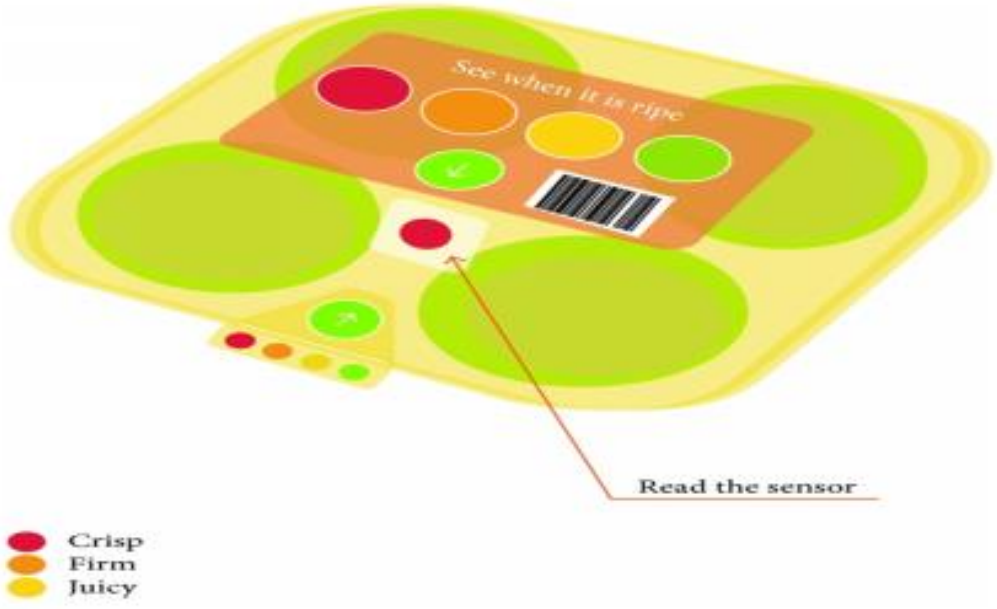


FIGURE 8: SCHEMATIC REPRESENTATION OF RIPE SENSE INDICATORS

- **Radio Frequency Identification (RFID)**

- **RFID tags are an advanced form of support data information that can identify and locate a product with a special tag that emits radio waves.**

- **These are classified into four types: active, passive, semiactive, and semipassive, depending on the power supply for communication and other functions.**

- **These devices may be coupled to an article, box, container, or pallet and therefore can be identified and tracked.**

- **RFID tags can be read from several meters away and beyond the line of sight active RFID have a reading range of 91 m or more and also have a battery that enables them to communicate autonomously.**

- **Passive tags have no internal power supply; therefore, are not able to communicate until the emission of an RFID reader is activated.**

- **The radio frequency field produced by the reader provides enough power to the integrated circuit of the label, to be able to reflect energy to the reader.**

- **RFID is still an expensive alternative aside the several obstacles to overcome its implementation in certain sectors, 100% data reliability, and specific limitations (short-range, narrow bandwidth, and low power).**

- **The long-term vision is able to print RFID labels directly onto paper or plastic instead of silicon, while investments in the components (sensors, tags, antennas, readers, connectors, cables, networks, controllers, software, and consulting and implementation processes) are expensive.**

- **RFID systems consist of two major components: transponder or tag and interrogator or reader, which create wireless data transmission.**

- **Each RFID tag applied to food packaging transmits the identification information to a reader, which allows communication with the RFID tag.**

- **The tag then transmits information back to the reader. This information in most cases is passed to a computer**

- **Readers are available as handheld computers or fixed devices that can be placed in strategic locations.**

- **RFID tags can be read-write (you can add information to the label or write on existing data) or read-only (information stored during manufacturing process).**

Figure 9: Schematic representation of the RFID system

- Many advances have been made in this field such as the development of a pH sensor embedded in a radio frequency transmitter without batteries in the following areas:

- Monitoring of deterioration processes of fish products

- RFID tag to control the freshness of meat

- RFID tag with an optical oxygen indicator for use in MAP

- RFID tag with a temperature sensor, a gas sensor, a reader, and a server, making up a tracking system for the freshness of pork

- RFID tag with sensors capable of measuring temperature, humidity, and the presence of volatile amine compounds, to estimate cod fish freshness

- RFID tag along with CO_2 and oxygen sensor for monitoring the freshness of vegetables

- System real-time evaluation of the freshness of packaged milk, marketing, and distribution using RFID tags.

Monitoring of Food Security using Nanotechnology

- **Nanotechnology involves the study, design, creation, synthesis, manipulation, and application of materials, devices, and functional systems through the control and exploitation of phenomena and properties of matter on a very small scale, usually between 1 and 100 nanometers' length.**

- **Nanotechnology is an interdisciplinary powerful tool for the development of intelligent packaging systems.**

- **The new packaging technologies will depend on the development of nanomaterials and nanoparticles such as:**
  - **nanoparticles**
  - **nanotubes**
  - **nanofibers**
  - **nanocylinder**
  - **nanosheets.**

- **The unique optical and electronic properties of this nanomaterial enable the development of a new generation of electronic devices, for example, nanotransistors to build future nanoprocessors and nanomemory, nanobattery, and nanosensors.**

- **For the development of IP, the integration and technological advancement of the sensors, nanosensors, and indicators are essential.**

- **A sensor/nanosensor measures only certain aspects, while an indicator integrates measurement and display.**

- **The sensors and nanosensor must be connected to a device for signal transduction of the receptor, while an indicator directly provides qualitative or semiquantitative information of the quality for a visible change.**

- Nanotechnology enables the application of nanosensors in the food packaging to control their quality, during the various stages of the logistic process, and to ensure product quality to the final consumer.

- Nanotechnology through IP can help in providing authentication, tracking, and locating product features to avoid falsification, adulteration, and prevention in the diversity of products intended for a specific market.

- There are still many concerns for consumers of food nanotechnology; one of the most important is the uncertainty of the behavior of nanoparticles in the body and the toxic effects they could have.

- For this, it is necessary to establish a set of protocols and regulations on the food security of IP implications.

Advantages of Intelligent Packaging in Food Security

- Intelligent packaging actively monitors and control factors of deterioration such as temperature, humidity, and gas composition within the container, extending the shelf life of perishable foods.
- It helps reduce decomposition, preserve product freshness, and reduce post-harvest losses.

- **Quality Monitoring and Assurance:**
- Intelligent packaging can provide real-time information about the food's quality and safety by incorporating sensors and indicators.

- It detect and report changes in temperature, microbial growth, and other indicators of product deterioration, thereby allowing for precautionary steps to ensure adequate preservation in food quality

- **Traceability and Supply Chain Management:**

  Intelligent packaging can improve supply chain traceability by incorporating technologies such as RFID identifiers.

- **This improves transparency and accountability, allowing for more effective inventory management, recall procedures, and food distribution and storage control.**

- **By actively monitoring the condition of packaged food, intelligent packaging can assist in identifying and preventing potential spoilage or quality problems.**
- **This reduces food waste and losses, increasing the amount of food that reaches consumers and contributing to food security.**

- **Consumer engagement and information:**
- **Intelligent packaging can provide consumers with valuable product information such as origin, ingredients, nutritional value, and preparation instructions. This enables consumers to make educated choices and promotes food safety practices.**

Conclusion

- **By utilising the capabilities of intelligent packaging, it becomes possible to address key food security challenges, such as post-harvest losses, inadequate storage facilities, inefficient supply chains, and a lack of product information.**

- **By enhancing the preservation, monitoring, and traceability of food, intelligent packaging plays a vital role in assuring food availability, accessibility, and stability, thus serving as a prerequisite for attaining food security objectives.**
- **The use of intelligent packaging is therefore recommended for use by all the stakeholders in the food value chains in Nigeria**

Non-Destructive Post Harvest Processing: Between Image Processing, Artificial Neural Networks and Artificial Intelligence

NON-DESTRUCTIVE POST HARVEST PROCESSING: BETWEEN IMAGE PROCESSING, ARTIFICIAL NEURAL NETWORKS AND ARTIFICIAL INTELLIGENCE

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NON-DESTRUCTIVE METHODS

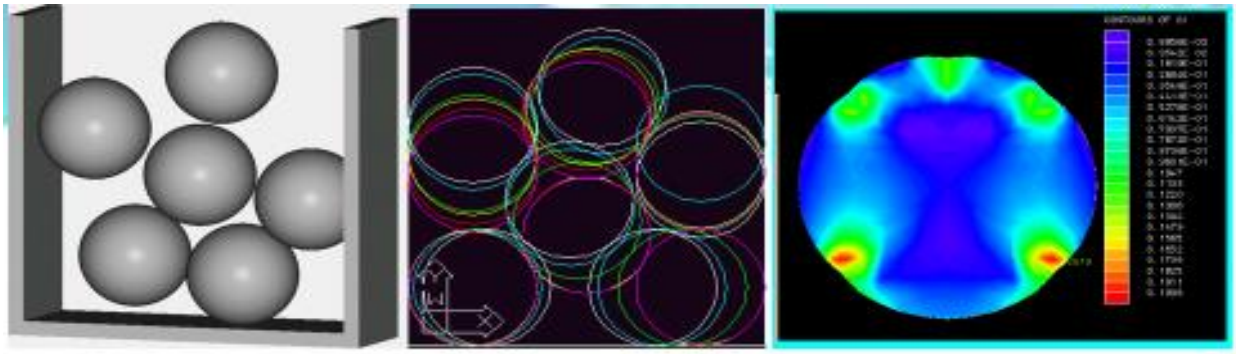
- Assessment of the properties and quality of the food products in a manner that does not destroy the product even before harvest and along the distribution chain.
- The availability of reliable and rapid non-destructive equipment provides information based on the food quality directly with high accuracy through the integration of various algorithm tools.
- (Cheng and Sun, 2015 reported several algorithms that are widely used for non-destructive applications
  - regression analysis
  - partial least squares (PLS)
  - support vector machine (SVM)
  - principal component analysis (PCA)
  - discriminant analysis
  - artificial neural network (ANN)
  - Image processing and machine vision (Artificial intelligence)
  - etc.

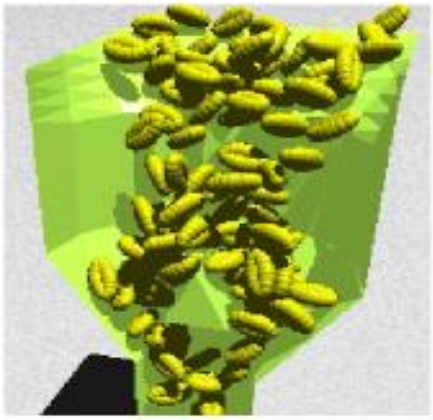
NON-DESTRUCTIVE METHODS

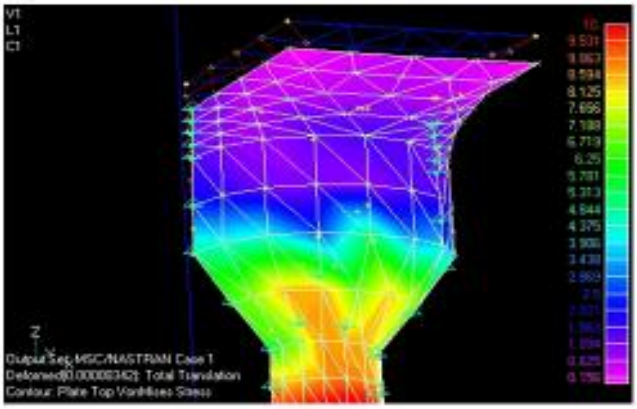
- Non-destructive methods are recent advances in the effective evaluation and monitoring process of the quality and safety of food and agricultural products.
- it has become a priority approach in the agricultural and food industries due to its tremendous benefits over the conventional methods that are time-consuming, destructive, subjective, require complicated analytical skills, and are not suitable for automation
- Mostly covering post-harvest operations

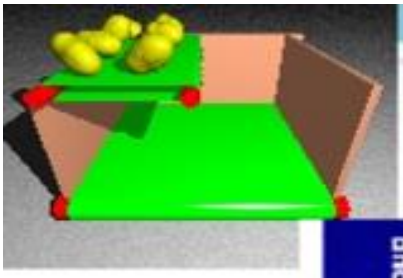
NON-DESTRUCTIVE METHODS

- PROCESSING OR QUALITY AND MONITORING ASSESSMENT
- QUALITY AND MONITORING ASSESSMENT – A SUBSET OF PROCESSING?
- PROCESSING
  - Combination of CAD with numerical and the digital methods
  - Machine design and operations predictable
  - Performance assessment









Biological Systems Engineering Group

SIMULATION

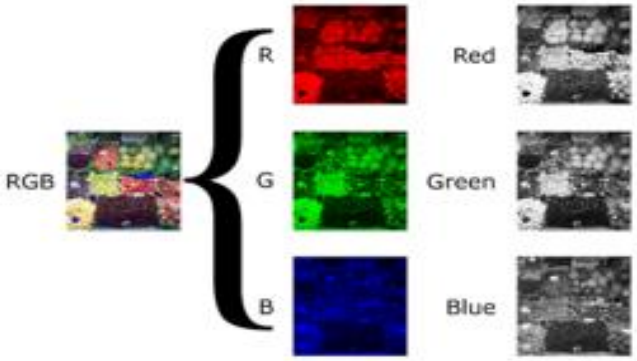
Donuts sliding on conveyers

POST HARVEST PROCESSING

- In agriculture, **postharvest** handling is the stage of crop production immediately following harvest, including
  - cooling,
  - cleaning,
  - sorting and
  - packing.
- The instant a crop is removed from the ground, or separated from its parent plant, it begins to deteriorate.
  - Cassava
  - Fish
- Determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product.

What is an Image?

- **An image is a graphical representation of an object (Physical)**
- **Digital image is represented by its dimensions (height and width)**
- **A finite set of digital values called picture elements (pixels).**
- **A 500 x 400 (width x height), the total number of pixels in the image is 200000**
- **Pixels are arranged and processed in row and column form and analysed using Matrix formation**



What is an Image?

- Pixel is a point on the image that takes on a specific shade, opacity or color. It is usually represented in one of the following:
  - Grayscale - A pixel is an integer with a value between 0 to 255 (0 is completely black and 255 is completely white).
  - RGB - A pixel is made up of 3 integers between 0 to 255 (the integers represent the intensity of red, green, and blue).
  - RGBA - It is an extension of RGB with an added alpha field, which represents the opacity of the image.

GREY SCALE RGB

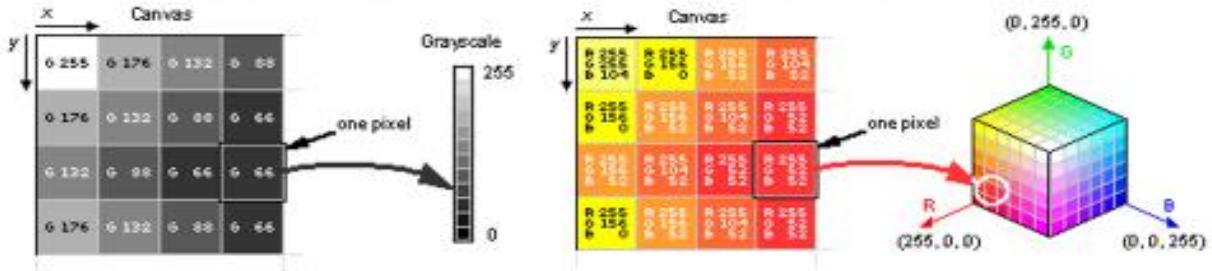
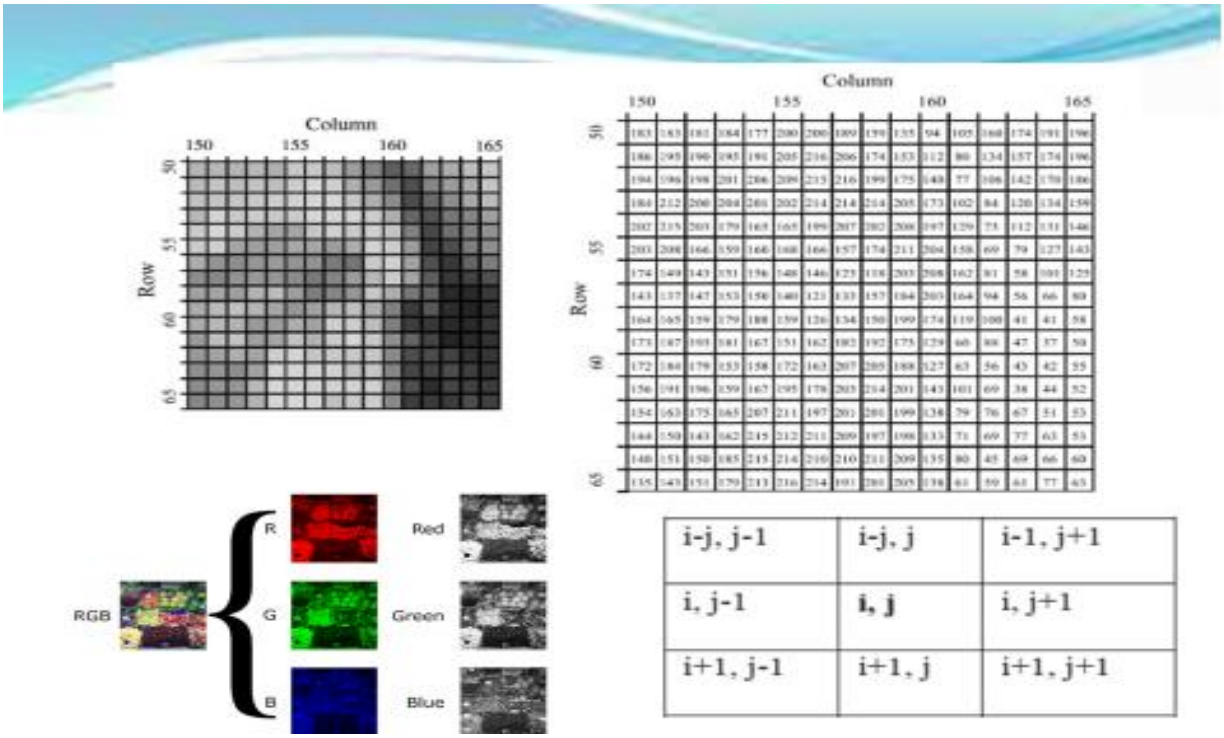
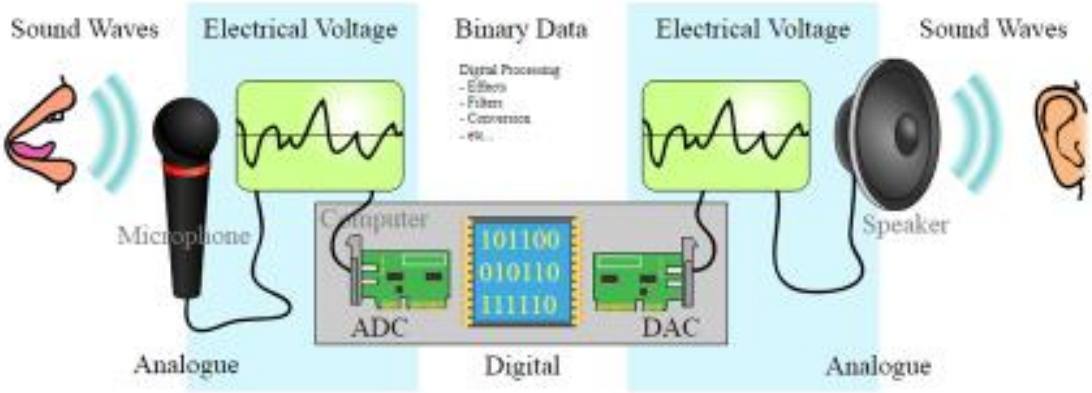


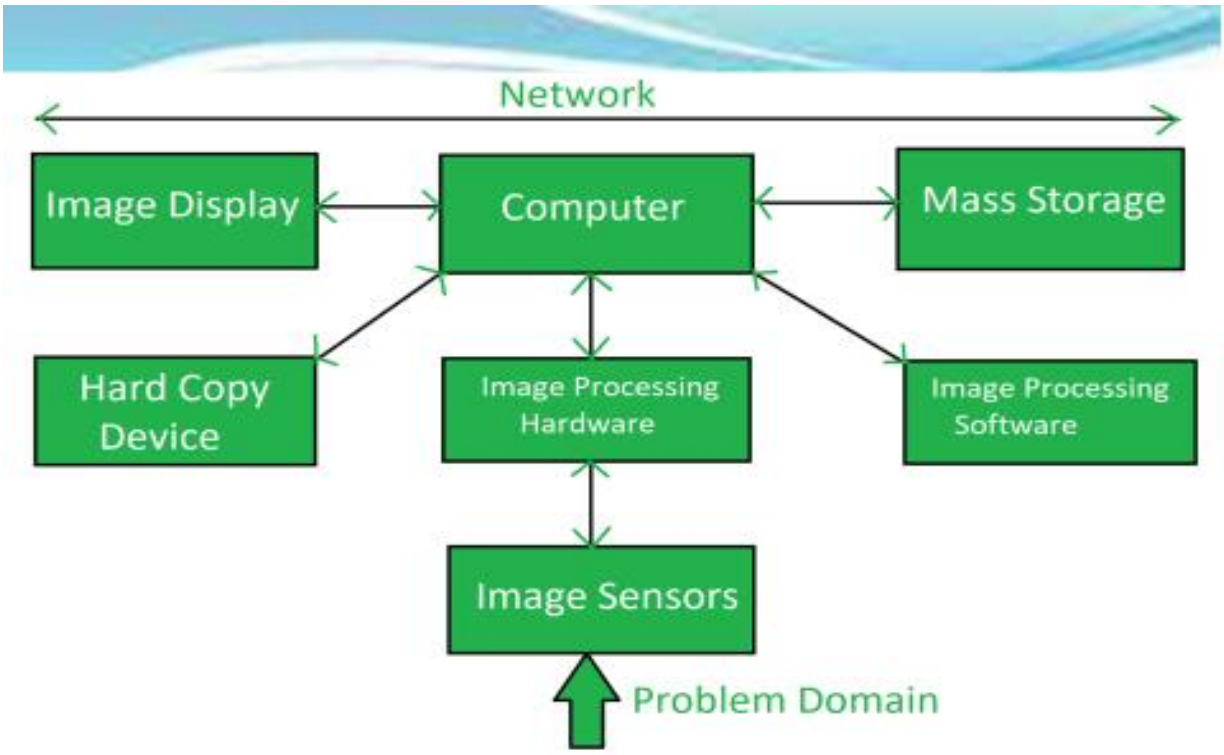
Image Processing

- Fixed sequences of operations that are performed at each pixel of an image
- The features (resolution, colour, opacity, shade etc) of each pixels are represented in digital form
- Each pixel when manipulated using matrix analysis leads to transformation of an image and extraction of useful information.
- The image processing system usually treats all images as 2D signals when applying certain predetermined signal processing methods.



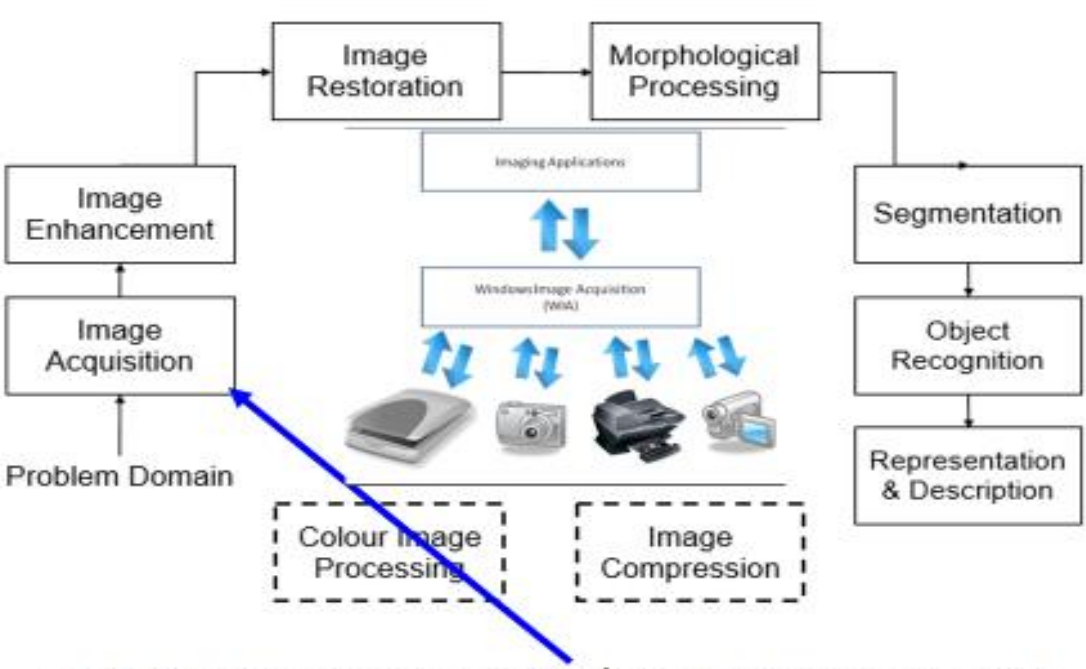
i-j, j-1	i-j, j	i-1, j+1
i, j-1	**i, j**	i, j+1
i+1, j-1	i+1, j	i+1, j+1



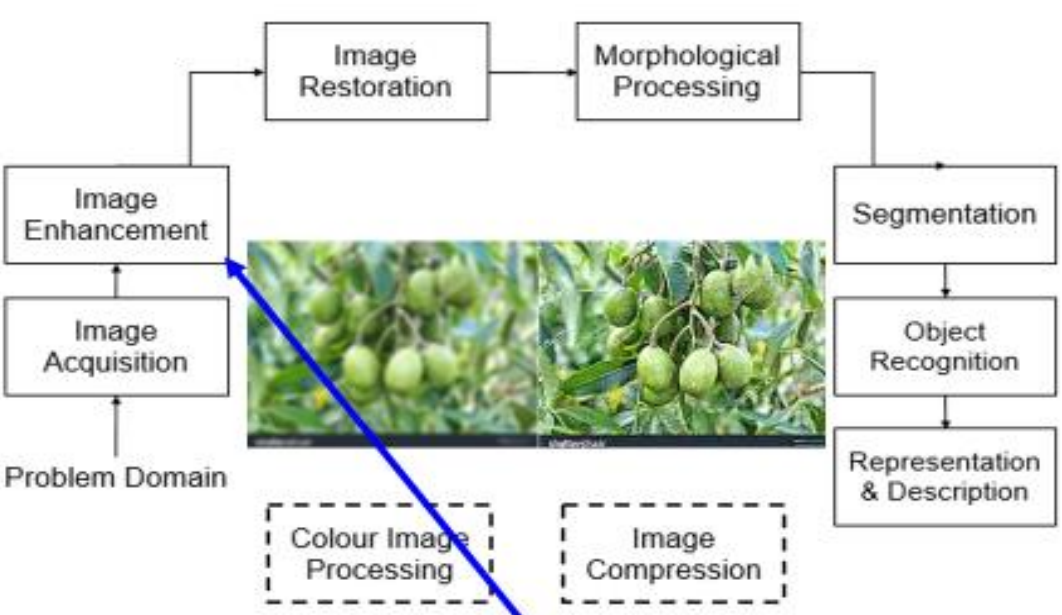


Types of Image Processing

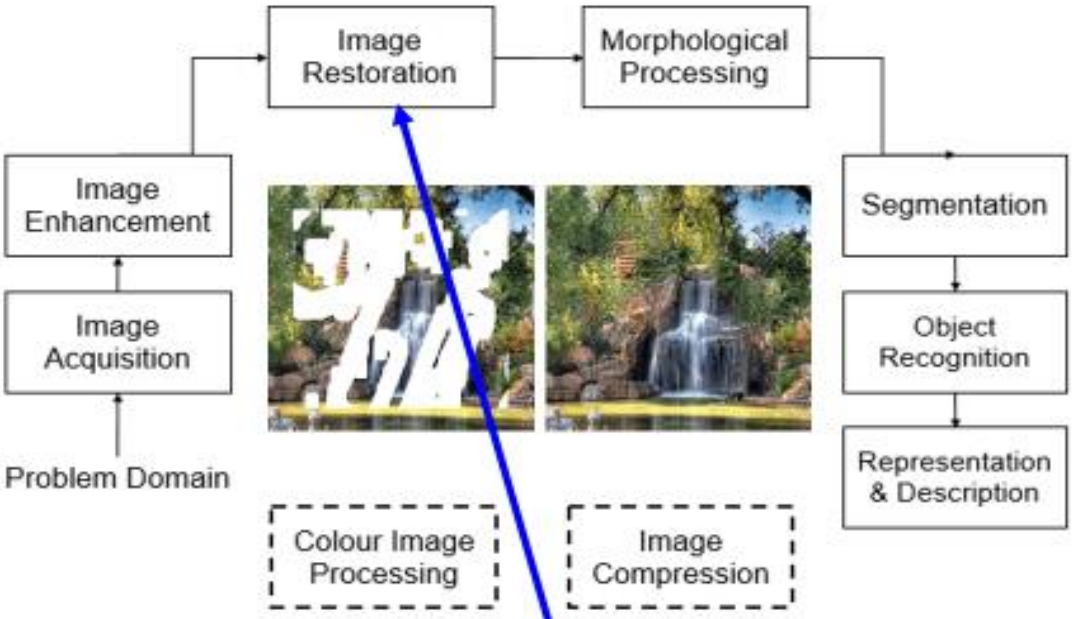
- **Visualization**
  - **Find objects that are not visible in the image**
- **Recognition**
  - **Distinguish or detect objects in the image**
- **Sharpening and restoration**
  - **Create an enhanced image from the original image**
- **Pattern recognition**
  - **Measure the various patterns around the objects in the image**
- **Retrieval**
  - **Browse and search images from a large database of digital images that are similar to the original image**



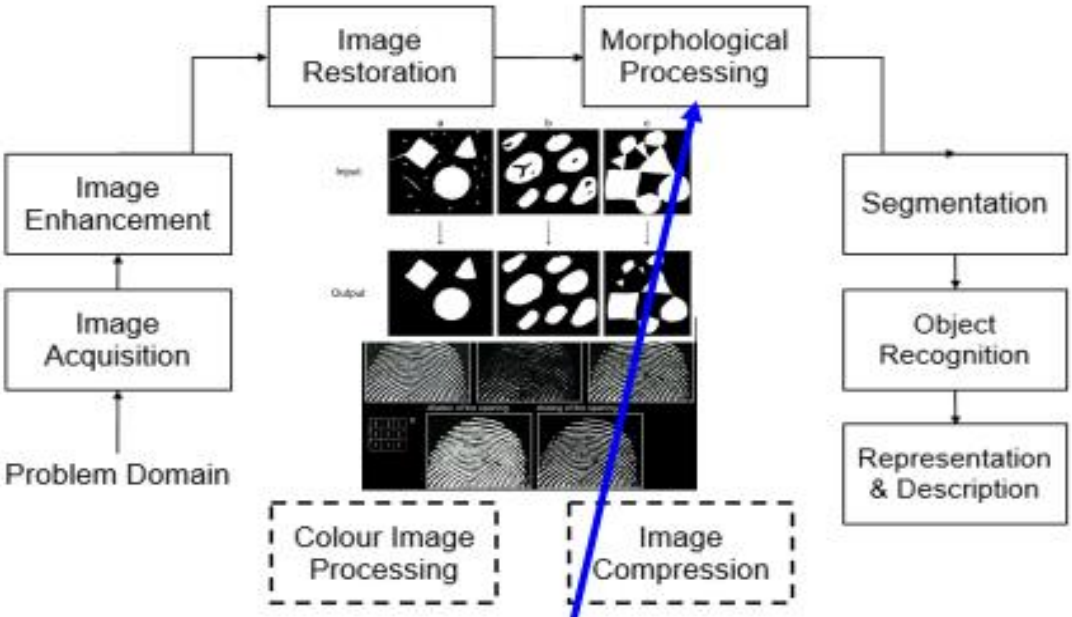
First step in image processing known as preprocessing. Involves retrieving the image from a source, usually a hardware-based source.



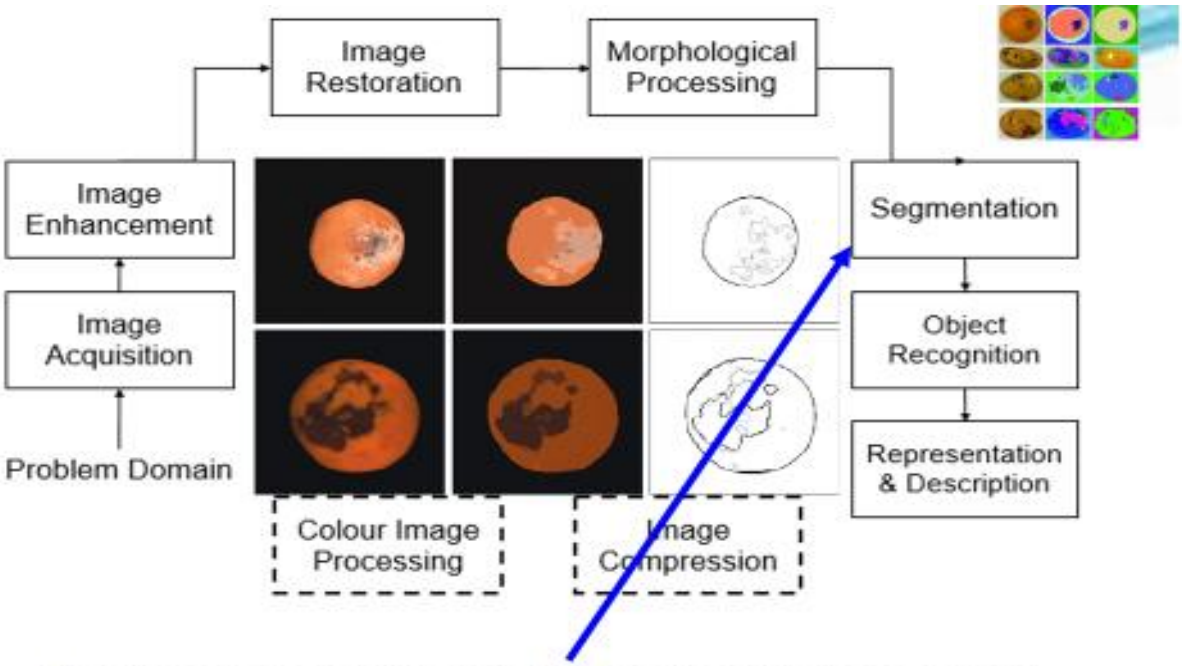
Process of bringing out and highlighting certain features of interest in an image that has been obscured. This can involve changing the brightness, contrast, etc.



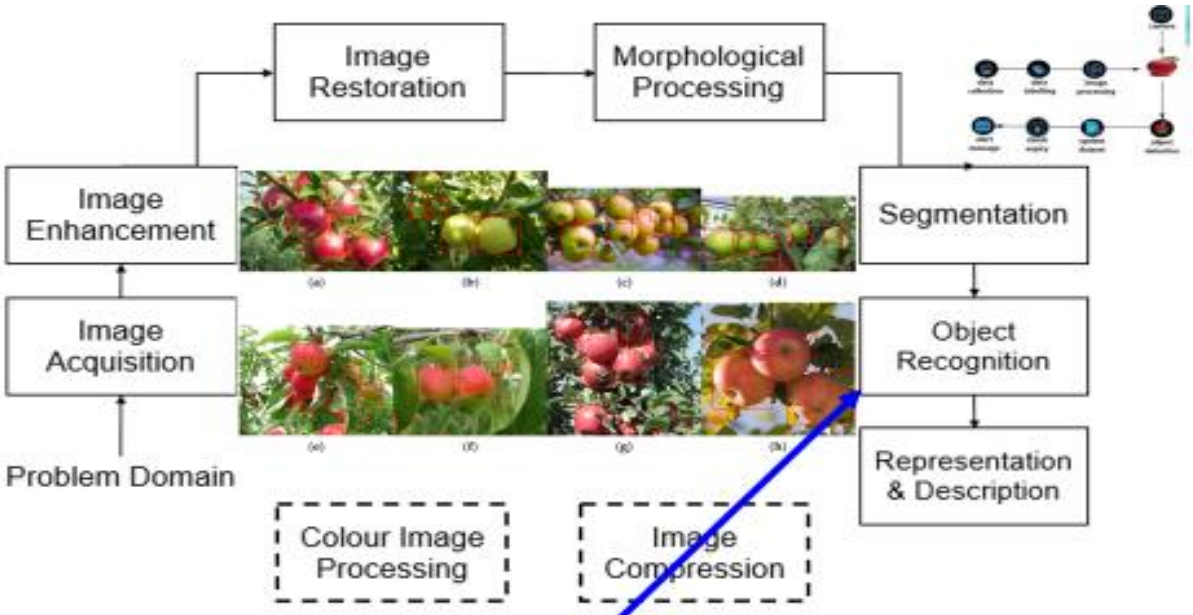
Process of improving the appearance of an image. However, unlike image enhancement, image restoration is done using certain mathematical or probabilistic models.



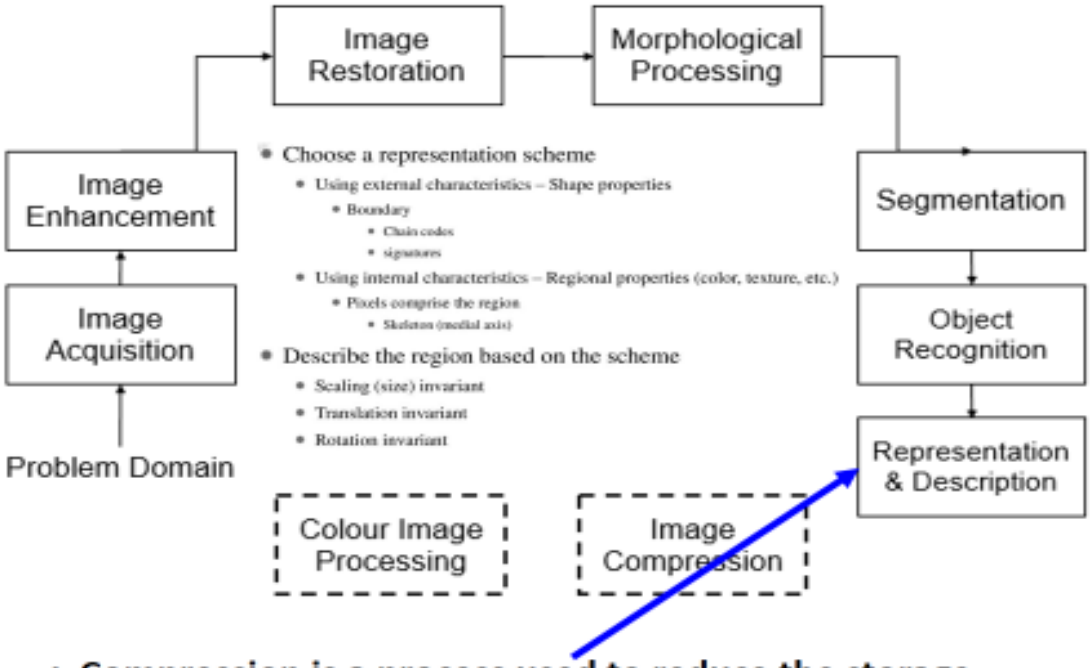
A set of processing operations for morphing images based on their shapes. Extracting and enhancing useful features (edges, shapes etc). MATLAB, PYTHON)



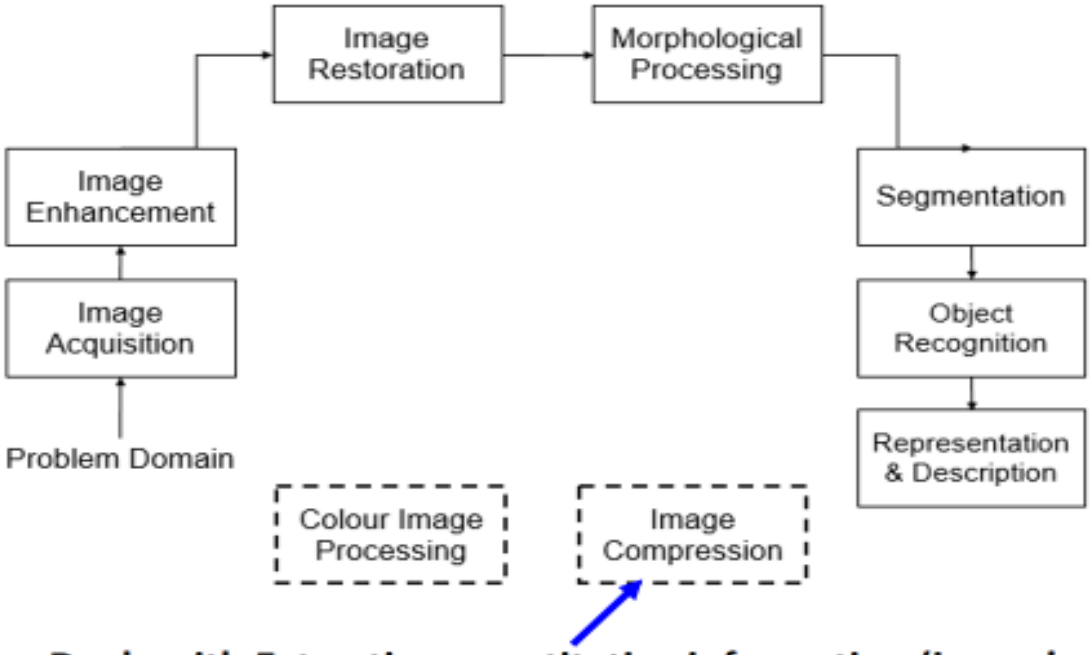
Partitioning an image into its constituent parts or objects. Feature extraction



Recognition may assign a label to an object based on its description. Overlaps with ANN, AI, Machine learning (robotics). Picks information from existing database and assign



- **Compression is a process used to reduce the storage required to save an image or the bandwidth required to transmit it. This is done particularly when the image is for use on the Internet.**



Deals with Extracting quantitative information (image's characteristics and regional properties) that helps differentiate one class of objects from the other.

ARTIFICIAL NEURAL NETWORK

MACHINE LEARNING

Supervised learning

- **The goal is to learn a mapping inputs x to outputs y, given a labeled N set of input-output pairs**

$$D = \{(x_i, y_i)\}_{i=1}^{N}$$

- **D is called the training set, and N is the number of training examples.**
- **A mathematical algorithm to learn an underlying mapping function that maps input to the output.**
- **The aim is to the mapping function is estimated and the output predicted when an entirely new set of input data is provided.**
- **These networks of mapped functions created artificially forms the neuron for comparisons**
- **Supervised learning is widely used in many applications, such as classification, pattern recognition, and regression problems**

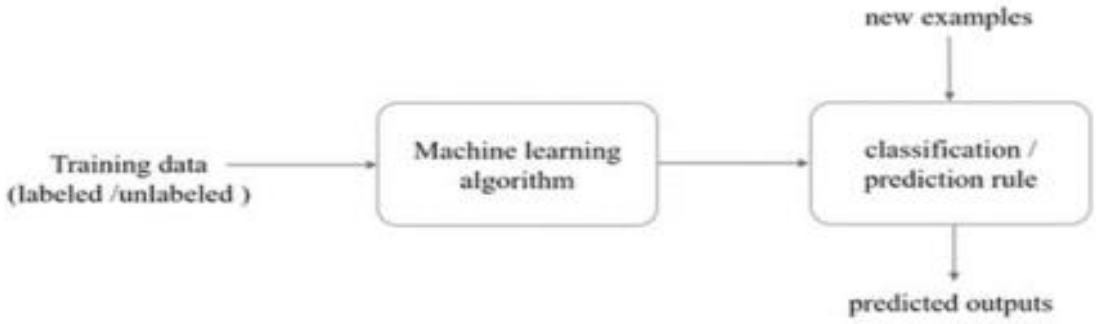
ARTIFICIAL NEURAL NETWORK

Unsupervised learning

- **only inputs are given**
- **the goal is to find 'interesting patterns' in the data and registered them as the targets**
- **the algorithm learns through structuring data patterns and predicts the output.**

$$D = \{x_i\}_{i=1}^{N}$$

- **Glorified validation?**

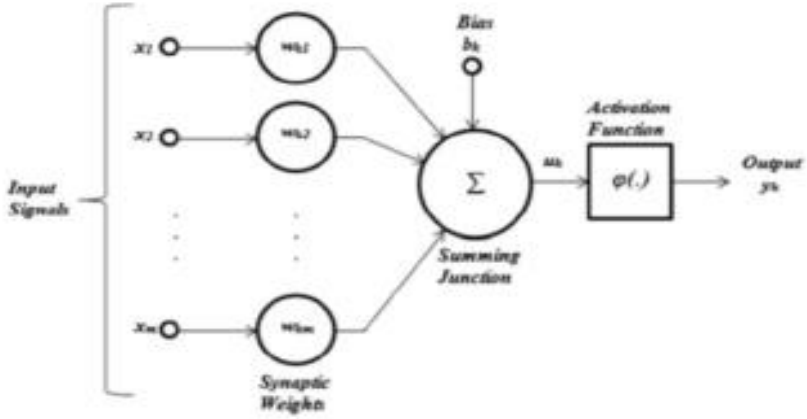


ARTIFICIAL NEURAL NETWORK

- a system that is inspired by the connections of neurons in human brains
- a single block of mathematical entity that processes information and is essential in the functioning of a neural network [71].
- has three essential elements:
  - a set of connection links that have their weights
  - a summation point
  - and an activation function.

$$u_k = \sum_{j=1}^{m} w_{kj} x_j$$

$$y_k = \Phi(u_k + b_k)$$



- where u_k is linear combiner output; ω_{k1}, ω_{k2}, ω_{k3}, . . . ω_{km} are synaptic weights; x_1, x_2, x_3,
- . . . x_m are inputs; bk is the bias that has the effect of lowering the input activation function;
- $\phi(.)$ is the activation function; y_k is the output of the neuron

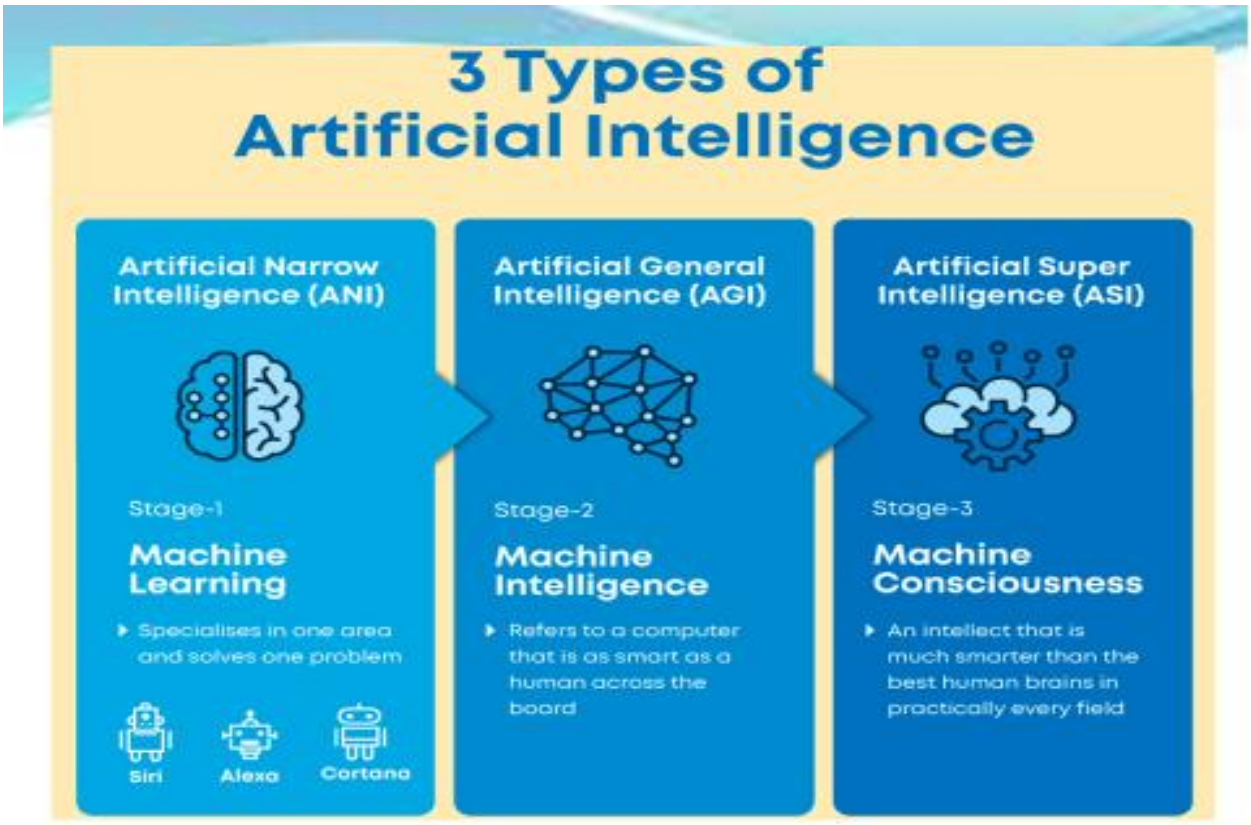
ARTIFICIAL INTELLIGENCE

- **Transforming the**

Images/vision to neurons then intelligence

Objects Thoughts practicality

- **The science and engineering of making intelligent systems.**
- **Intelligent systems could be**
  - **hardware (e.g., robotic arms during some repetitive jobs like capping drink bottles)**
  - **software (e.g., algorithms that recognize patterns in food on a production line),**
  - **a combination of both (e.g., autonomous rovers that make independent decisions based on certain events like breakges in food).**
- **Artificial Intelligence technology, along with computer vision, image processing, object detection, and machine learning algorithms are widely used and analyzed and have proven to be effective in nearly all aspects of life.**



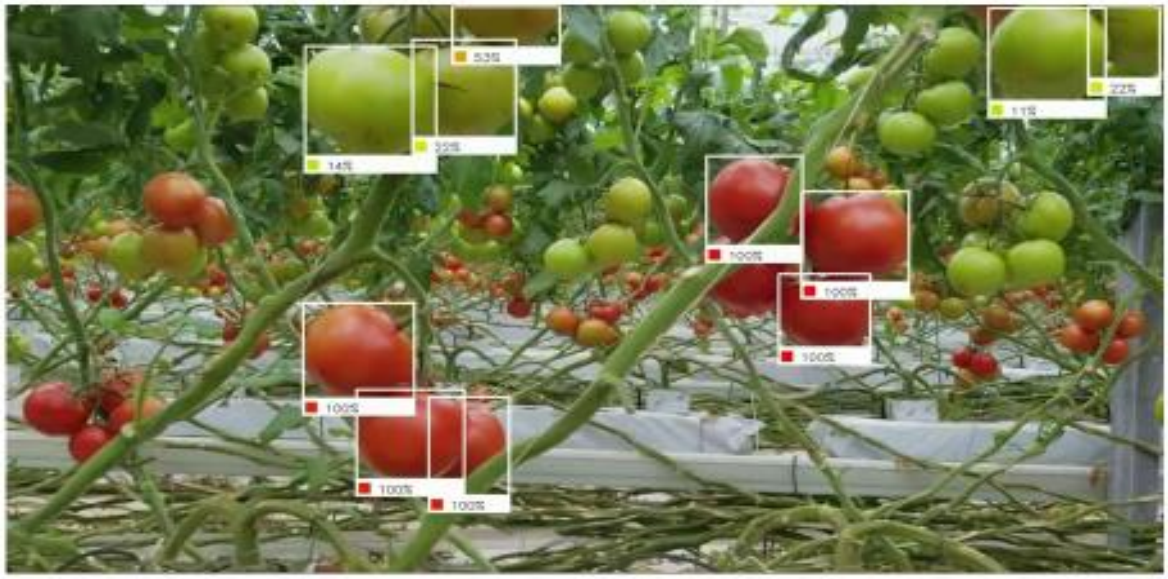
ARTIFICIAL INTELLIGENCE

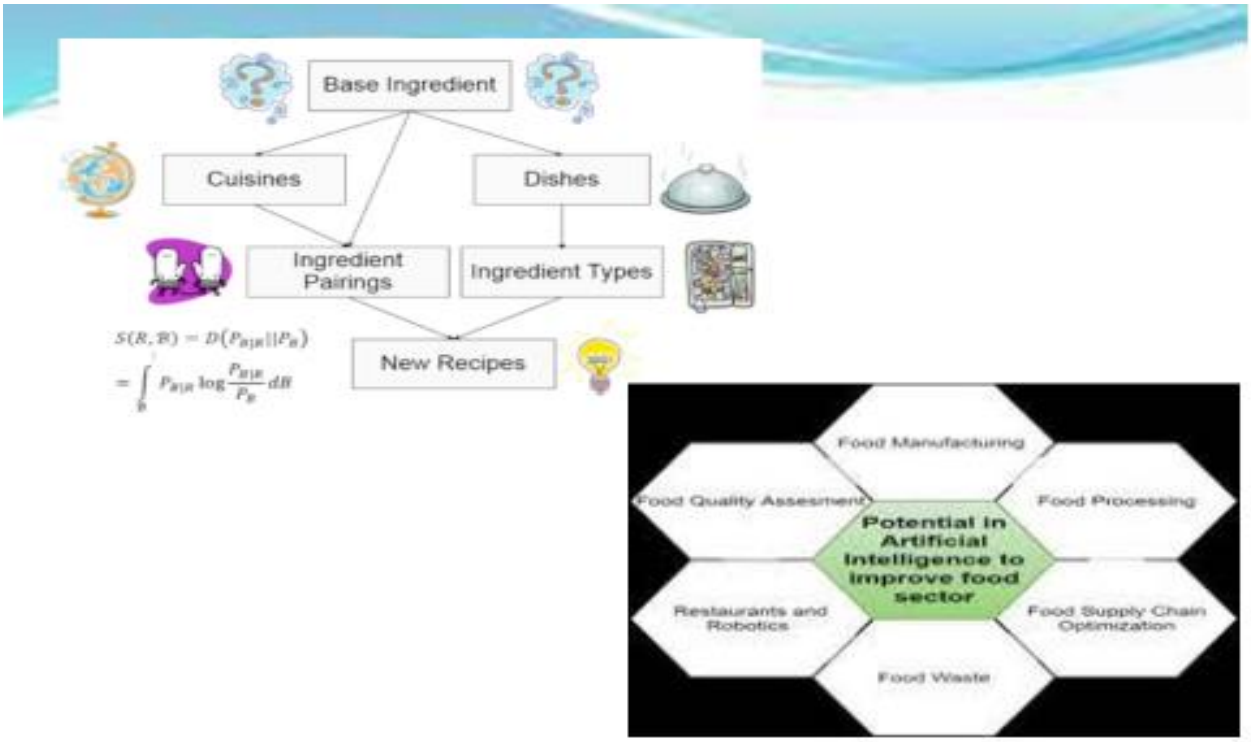
- WHAT YOU SEE ALWAYS

- RECALL THE EMERGENCE OF THE UAV'S (UNMANNED AERIAL VEHICLES – AKA DRONES)

AGRICULTURAL APPLICATIONS

RECALL IMAGE RECOGNITION, REPRESENTATION AND DESCRIPTION





ARTIFICIAL INTELLIGENCE

Post harvest processing

- AI can maximize output and reduce waste, by replacing people on the line whose only jobs are to distinguish identify items unsuitable for processing.
- Decision making of this type at speed requires the senses of sight, smell, and their adaptability to adapt to changing circumstances.
- AI brings even more to the table through augmented vision, analyzing data streams either unavailable through human senses, or where the quantities of data are overwhelming.

APPLICATIONS IN AGRICULTURE

Mostly field operations

- Crop yield Forecasting
- Plant Leaf classification and identification
- Weed classification and detection
- Equipment auto control in field operations (unmounted tractor)
- Unmounted Aerial Vehicle (Drones) for field operations

Plate 5: Original images of fungi growing on some food samples

Figure 9: Image of the fungi as extracted by image processing

Plate 4: Original images of the vegetables for day 14 and 18 of image acquisition

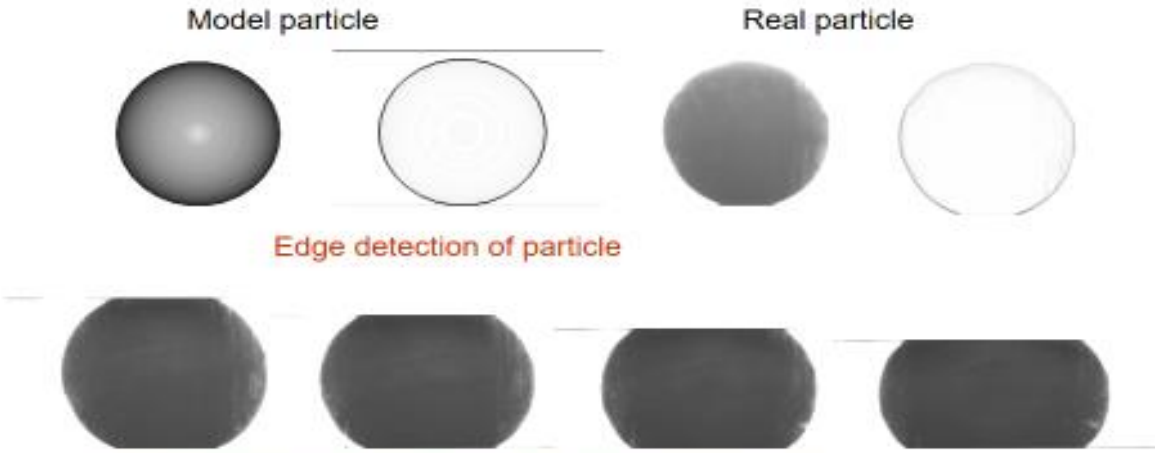
Figure 5: Extracted solid form

Figure 6: Extracted boundary of Amaranthus leaves

RAJI AND OYEFESO, 2016

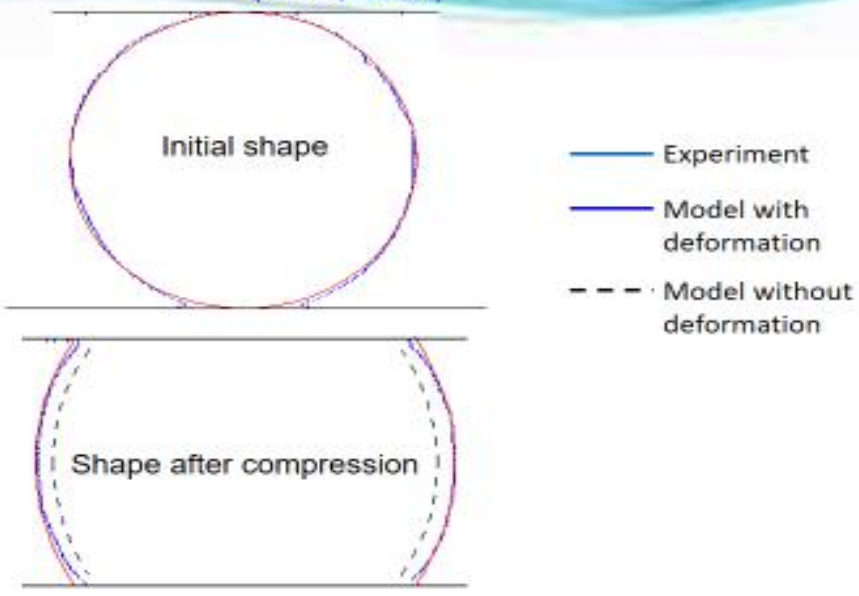
Post Harvest Applications initiatives

Deformation of particulates under load - Post Processing: Image analysis (RAJI, 1999)

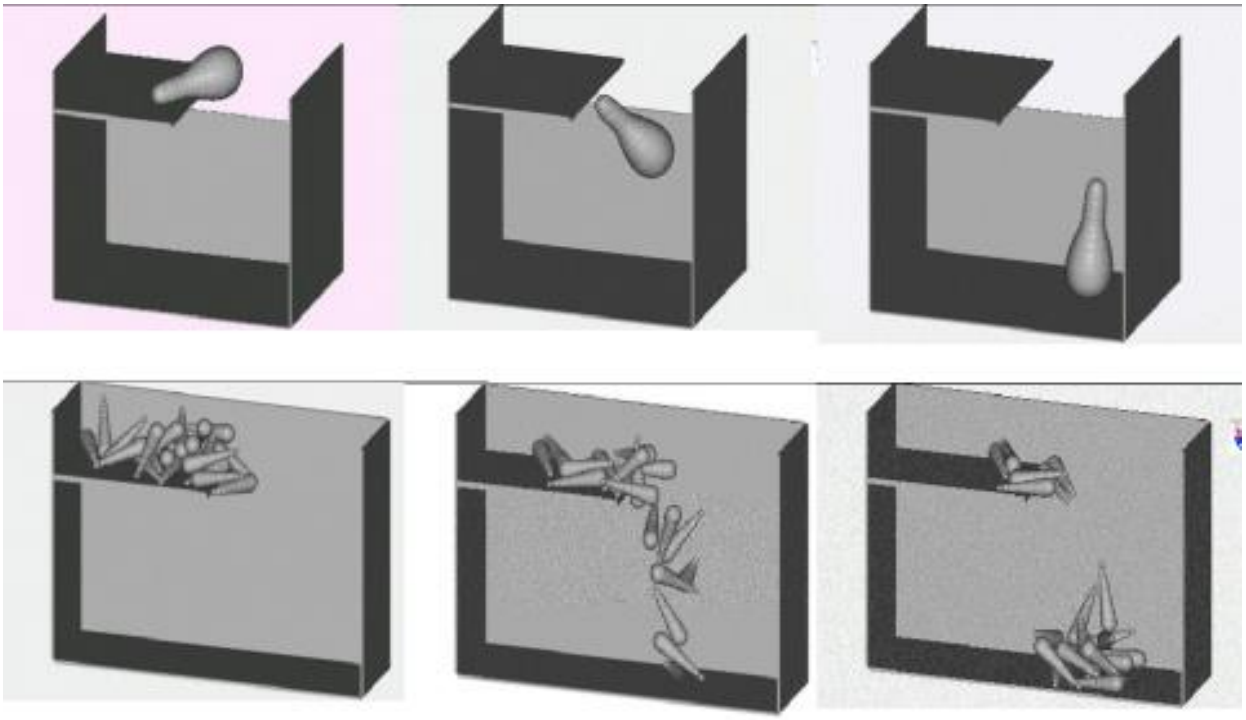


Biological Systems Engineering Group, University of Newcastle

Deformation of particulates under load - Post Processing: Image analysis (RAJI, 1999)



Edges of the superimposed images from experiment and simulation
FROM IMAGE PROCESSING TO ANN TO AI



FAVIER, ABBASPOUR, KREMMER AND RAJI, 1999

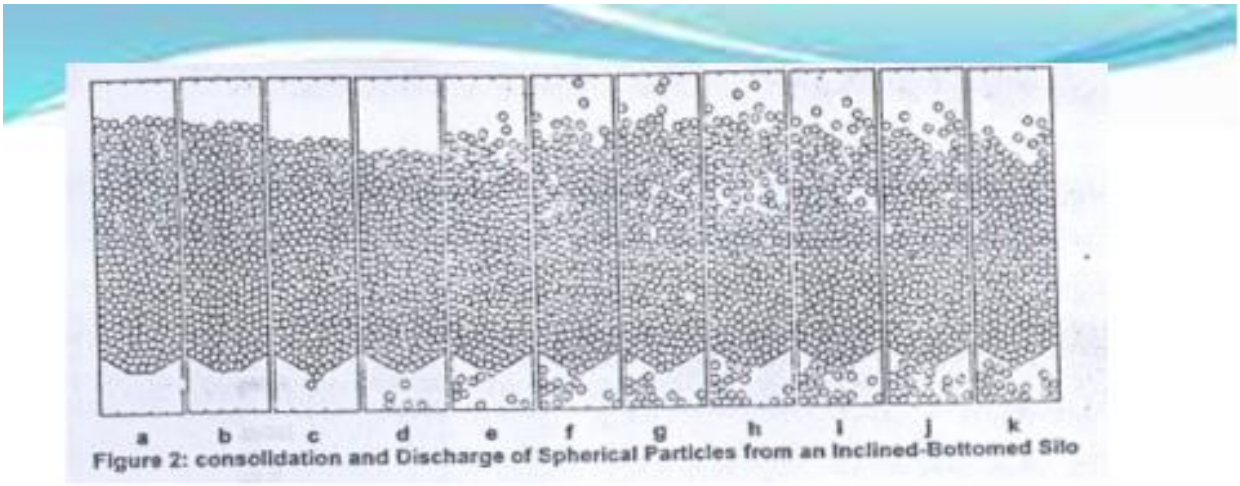
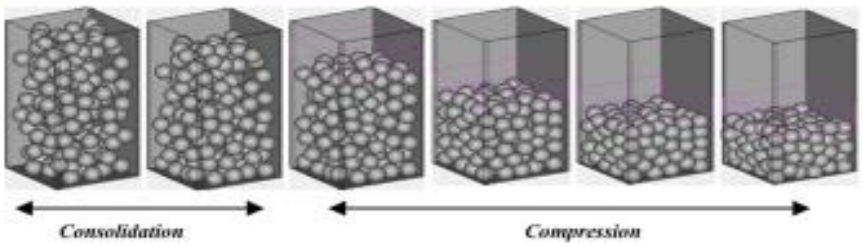


Figure 2: consolidation and Discharge of Spherical Particles from an Inclined-Bottomed Silo



RAJI, 2002 and RAJI, 2004

THE INTERSECTION

- Moving from experimental validation to
- Image processing and superimposing for validation to
- ANN and
- Machine vision and learning (through Artificial Intelligence)
- Food industry and processing will witness a revolution

PRE-REQUISITES

- KNOWLEDGE OF SYSTEM
- PROGRAMMING
  - (FORTRAN, C++, PYTHON, MATLAB etc)
- CODING/DEVELOPMENT
- MODELLING

REFERENCES

- **RAJI, A. O** and J. F. Favier (1998). Discrete element modelling of the deformation in particulate agricultural materials under bulk compressive loading. *Proceedings of the International Conference on Agricultural Engineering*, Oslo (August, 1998) (e-proceedings on CD).
- **RAJI, A. O.** and J. F. Favier (1999). Discrete element modelling of the compression of an oil-seed bed. Paper No. 996109 presented at the *Annual International Meeting of the ASAE-CSAE-SCGR*, Toronto, Ontario, Canada.
- Favier, J. F; Abbaspour-Fard, M. H; Kremmer, M. and **A. O. RAJI** (1999). Shape representation of axi-symmetrical, non-spherical particles in discrete element simulation using multi-element model particles. *Engineering Computations: International Journal for Computer-Aided Engineering and Software*, Vol. 16, No. 4: 467 - 480.
- **RAJI, A. O.**, Fagboun, A. A. and M. K. Dania (2000). An approach to detecting defects in food products. *Proceedings of the 1st International Conference and 22nd Annual Conference of the Nigerian Society of Agricultural Engineers*, Ibadan, Nigeria, Vol. 22: 36 - 39.
- **RAJI, A. O.** and J. F. Favier (2004). Model for the deformation in agricultural and food particulate materials under bulk compressive loading using discrete element method I: Theory, model development and validation. *Journal of Food Engineering*, Vol. 64: 359 - 371.
- **RAJI, A. O.** (2009). Image processing analysis in modern laboratory management. *Paper presented at the World Bank Step-B Sensitisation and Modern Laboratory Management Workshop for Federal Institute for Industrial Research Oshodi Research Scientists and Technologists*, 26 - 28, May, 2009.
- **Raji, A. O.** and Oyefeso, B. O. (2016). Features extraction in agricultural products using computer image processing. *Proceeding of the 37th National Conference and Annual General Meeting of Nigerian Institution of Agricultural Engineers (NIAE), October 4th – 7th, 2016, Federal University of Technology, Minna, Niger State pp 656 - 664.*